NAVAL POSTGRADUATE SCHOOL
Monterey, California

THESIS

COMEL: A COMMUNICATIONS WAR GAME

by

Katherine Rowe
Robert Cecil Allgood Jr.

March 1983

Thesis Advisor: G. R. Porter

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The game has two portions, an Acquisition Phase and an Operations Phase. In the Acquisition Phase, Players budget for research and development,

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The programs are written in structured FORTRAN 77, with extensive comments and external documentation, so that they can be read, understood, modified, and expanded by those with limited programming experience.

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COMEL: A Communications War Game

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ABSTRACT

COMEL is a communications oriented war game developed by the Joint Telecommunications Staff Officers' Course at Keesler AFB. The war game has been automated to run on a VAX/VMS computer. The program allows computer assisted play of the game using a manual gameboard.

The game has two portions, an Acquisition Phase and an Operations Phase. In the Acquisition Phase, players budget for research and development, manufacturing, purchase, and operations and maintenance of communications and electronic equipment for a Joint Task Force (JTF). In the Operations Phase, players allocate the available communications and electronic equipment to units, physical locations, or special missions and then direct the employment of the units and equipment in a war game.

The programs are written in structured FORTRAN 77, with extensive comments and external documentation, so that they can be read, understood, modified, and expanded by those with limited programming experience.

TABLE OF CONTENTS

I. BACKGROUND

Communications Electronics War (COMEL) was developed as a manual war game in 1982 by students at the Joint Telecommunications Systems Staff Officers Course (TSSOC) at Keesler Air Force Base, Mississippi. The goals of the game were to "integrate selected objectives of TSSOC into a single exercise" and to give an understanding of "the complexities of joint communications systems acquisition and planning." [Ref. 1]

The basic concept of the game was developed by Major James L. Parrine and other TSSOC faculty members. Their concept called for a game based on the assumption that "operational forces are only as effective as the comm supporting them." [Ref. 1] Their initial concept was primarily concerned with acquisition. Each team was to begin the game year with given operational communications systems. The teams would have research, acquisition, and intelligence decisions to make with limited resources. Subsequent turns would represent budget years. Random events would by entered into the game via "Gimme a Break" and "Awshucks" cards. The initial concept called for the development of an objective evaluation criteria to determine the game winner.

The concept was further refined to include a combat phase with faculty members as controllers and evaluators. Preliminary design goals were defined and given to the students.

The manual game was then designed by three students as their major project for the course. Credit for the game design goes to Captain Matt Downing (USA), Captain Milbert Grabowiecki (USAF), and Captain John Ortman (USAF). They designed most of the manual game materials that were used in developing this thesis and the computer version of COMEL. 1st Lt Diana Youngs, who has been involved in the evolution of the manual game, provided additional materials.

The goal of this thesis was to develop a computer version of COMEL to incorporate most of the features of the manual version and to allow later expansion of the game. The computer version was designed in two portions. Robert Allgood designed the control modules and the Acquisition Phase modules; Katherine Rowe designed the Operations Phase modules. The two portions were then combined to form a single game. The computer version is resident in the C2 Wargaming and Research Laboratory (C2 WARLAB) at the Naval Postgraduate School (NPS) and can be modified for use at TSSOC when a computer facility is available. A detailed User's Manual and Maintenance Manual have been written and are attached as appendices to this thesis. The scripts of these manuals are also available through the C2 WARLAB.

II. GAME CONCEPT AND MODELS

A. GAME OVERVIEW

COMEL is logically divided into an Acquisition Phase and an Operations Phase. Each of these phases progresses through a series of turns. The turn for Acquisition is a budget year and for Operations is a game step of approximately one day.

The Umpire has complete control of the sequence of events in COMEL The game can be run at the convenience of the players involved. The Acquisition Phase can be played in one session and the Operations Phase started during a seperate session, or the Operations Phase can be set to start automatically should the war occur (by program control or by the Umpire's decision). The Umpire can stop play of the game at the beginning of any turn. When COMEL is stopped in this manner, the Umpire may save the game files in one of the save areas set aside for this purpose. The Umpire and players will then have the opportunity to continue the game at some later time.

During the initialization of COMEL, the players must coordinate closely with the Umpire, to ensure proper synchronization. Players do not have any further input

effecting the administration of the game, which is under Umpire control.

Data files are available for a default game that is based on the manual version of COMEL. By substituting alternate files the Umpire can change the scenario. Detailed instructions on preparing alternate files are included in the Maintenance Manual.

The models used in COMEL will be discussed only briefly in this thesis since they are explained in detail in the attached Users' and Maintenance Manuals.

B. ACQUISITION PHASE

The Acquisition Phase of COMEL should give the players an appreciation of the complexities, in terms of time, money, and magnitude of decisions involved, in the procurement of systems to fulfill mission deficiencies.

All systems have life cycles.[Ref. 2] In terms of the Acquisition model used in COMEL, a system will begin its life cycle as soon as money is applied in research and development(R+D) or, for systems not requiring R+D, when money is applied to manufacturing for deployment (M+D). Some systems may already be in the life cycle process when the Acquisition Phase starts, if already in the inventory and operating.

Systems that can be acquired fit into five general categories:

a. Ground communications systems (HF, VLF, tactical, satellite ground terminals, and line-of-sight systems)

b. Communications satellites

c. Intelligence satellites

d. Electronic warfare systems

e. Special systems (AWACS, airborne command posts, and anti-satellite weapons).

There are actually three phases of the system life cycle; the planning period, the acquisition period, and the use period (the Operations Phase of COMEL). The planning period begins prior to the start of the computer portion of COMEL and continues throughout the game.

Before the game begins, players should be given basic scenario descriptions. (The default game includes CONPLANS and Commander's Planning Guidance which are included as attachments to the Users' Manual) They also need lists of combat units and available electronic systems. The players should decide in advance what systems they need to acquire to meet the threat. Planning continues throughout the Acquisition Phase as players react to budget constraints and intelligence.

The Acquisition Phase includes all those steps necessary to design, test and evaluate, produce, and install the planned systems. The stages in Acquisition can include normal Research and Development (R+D), accelerated Research and Development (AR+D), Manufacturing for Deployment (M+D),

normal Operation and Maintenance (O+M) and Reduced Operation and Maintenance (RO+M). All the above steps require annual budget money to be committed. There are also some intermediate steps that come between the steps listed above. After (R+D) the system enters a state called Finished Research and Development (FR+D). Players obligate money to move systems in this state into M+D (as well as those systems not requiring R+D). When systems finish M+D, they become available for purchase and can be placed in an operating status. However, due to the high cost of maintaining tooling, a system may disappear from a ready to be bought status if not procured the year available. In which case, that system would have to be started from scratch again. The life cycle is pictured in Figure 1.

R&D	M&D	O&M
AR&D	M&D	O&M

THE SYSTEM LIFE CYCLE

Figure 1

As with the acquisition of any real world systems, the budget is a major factor in most decisions; with an unlimited budget, one could procure everything available and the decision process would be simple. In COMEL the Umpire acts as the budgeting authority for the players (ie, Congress or DOD). Each year the players are allocated a

budget that, given an appropriate acquisition strategy, should permit the development within a few years of enough systems to meet the projected threat. The players then allocate their budget among the current systems in O+M, systems under M+D, and the R+D programs. War can occur any time after year two; the probability of war is low in year two and increases each year thereafter. The player has to balance the threat of war the next year against more effective systems that require several years to bring through the acquisition stages. The budget given the player may not be enough to attain all the player's procurement plans. The players then must prioritize and make tradeoffs to decide which systems are most essential to the mission. The player may save money by placing systems in reduced O+M or by scrapping certain existing systems.

The player should remember that there is an opponent who eventually will test the acquisition decisions made. The player may gain an advantage by purchasing intelligence from the Umpire. Intelligence may enable the player to take advantage of what the opponent is doing. As with any intelligence system, information obtained is not perfect and may be totally worthless. It should be used to aid in a decision but not as the driving force.

The last major factor in the acquisition process is time. Each turn has a time limit; if advanced planning was not adequate, decisions may be rushed. Time is also a

factor when considering the years required to make a system available for use in the field. The player therefore must account for the time required to develop and field equipment and must decide which systems to introduce into R+D. Of these, the player must decide which systems to select for AR+D, which to continue into M+D and O+M, which to scrap, and which to defer to the future (while considering the probability of war).

In the Acquisition phase, the player has two decision aids available to assist in the planning and acquisition of systems. These aids are a forecast of budget requirements and a force projection. Both are forecasts for the next five years. The budget forecast predicts costs for continued development, purchase, and operation of systems that are currently in the field or in acquisition. The force projection consists of two graphic presentations; one summarizes technical parameters of systems under development and in operation, the second shows a force assessment based on the weighted average of the technical parameters. A further description of these routines can be found in the Users' Manual.

The final stage of the system life cycle is the use period: The actual operation of the system. This is the point in COMEL where the Acquisition Phase ends and the Operations Phase begins.

C. OPERATIONS PHASE

The Operations Phase allows the players to test their acquisition decisions in simulated combat. At the beginning of the Operations Phase, the players allocate the systems they purchased to combat units or fixed locations. Throughout the war game, the players make decisions affecting the operations of their electronic systems and combat units. Through the communications, mobility, and combat models, the acquisition and allocation decisions that the players made are reflected in the conduct of the battle.

The war game pits two Joint Task Forces (JTFs) against each other in a race to gain control of key objectives on a hex map. The default game scenario has the Red and Green forces deployed in allied countries, Blue and Yellow. The Red and Green forces are trying to gain control of valuable mineral reserves and the port facilities in a neutral country, Utopia.

1. Communications Models

The communications models used in COMEL are based on a measure called C3 Effectiveness (or Effectancy). This value is a "measure of the overall ability of a communications system to support the mission of the unit it is assigned to." [Ref. 1] The C3 Effectiveness (C3E) in the manual game is a product of reliability, flexibility, and operability of an electronic system or a communications link (including both ends of the link). In the default version

of the computer game, C3E is also a product of reliability, flexibility, and operability; however, for communications systems the square root of the product is used to represent the C3E of one end of a communications link, since the two ends of a communications link are treated separately in calculations of connectivity.

The designers of the game define these three values as follows [Ref. 1]:

a. "Reliability coefficient: A system's ability to remain operational and perform according to specifications."

b. "Flexibility coefficient: A system's ability to accommodate various traffic fluctuations and procedural changes based on operational crises."

c. "Operability coefficient: A measure of the ease with which a system can be understood, operated, and maintained by those trained to do so."

Each of these measures is expressed as a decimal between zero and one. Only the resulting product, C3E, is actually used in the game models.

The C3E of communications systems is used to compute three measures of connectivity. These program variables, NCACON, C3EXT, and INTC3, are assigned values from zero to one. NCACON is a measure of the ability of the JTF headquarters to contact the National Command Authority (NCA). C3EXT is a measure of the ability of a unit to contact their JTFHQ. INTC3 is the measure of a unit's

internal, tactical communications. These three measures of connectivity are used throughout the game as the probability that necessary information can be passed from one level of command to another.

The C3E value of other electronic equipment, such as electronic warfare systems, is used to represent the probability that the system will satisfy its mission.

Other technical data, such as range, compatibility, mobility, and satellite beam width, are modeled directly in the game.

2. Movement Model

Movement of units is based on an optimum path routine and movement points (mobility). The players input goals (destinations) for their units. The optimum path routine calculates the best path for that type of unit to take to reach the goal, based on the terrain. Each hex along the path will require a certain number of points to traverse; for example, open terrain requires one point, mountains three, movement along a road takes one half point. The data files assign each unit a certain number of movement points per turn (files are created prior to game play). This mobility can be cut in half by poor internal communications (INTC3).

During a turn, each unit moves along the optimum path until it runs out of movement points, reaches its goal, or comes into contact (adjacent hex) with an enemy unit.

When in contact with the enemy, the player can have the unit assume one of three defensive positions (retreat, continue toward its goal, or stop in present position), or request approval of an attack. Approval level for attacks is set by the Umpire as Rules of Engagement (ROE). Three ROE are allowed: the Umpire can require NCA approval of all attacks, allow JTFHQ approval, or permit local unit commanders to attack targets of opportunity. For example, the NCA or JTF may want to maintain attack approval authority to ensure that the other side initiates hostilities, or to coordinate the timing of a preemptive, force wide attack.

3. Combat Models

The combat sequence of the game models most aspects of the modern, joint battlefield. In addition to ground combat, the game includes extensive air combat models, including interdiction, close air support, counter air, reconnaisance, and tactical airlift of airborne forces. Air-land forces include the JTFHQ, tactical fighter wings, armored brigades, mechanized brigades, and airborne brigades. Sea forces include carrier battle groups, amphibious task forces, and Marine forces.

The combat models themselves are very simple, depending primarily on computing the difference in various combat values (in the input data files) and applying a random factor. The requirement for communications

connectivity and the role of electronic warfare is modeled in more detail. The construction of these models is described in detail in the Maintenance Manual.

D. CRITIQUE OF MODELS

The three basic communications connectivity models, NCACON, INTC3, and C3EXT, are based on probability theory and are only as good as the C3 Effectiveness values that are entered through the initial data files. The method used by in the manual game and in the default computer game to calculate C3E is simple, but not necessarily the most appropriate method. Survivability, speed of transmission, traffic load, and other important considerations are not factors used in the calculation of C3E, and possibly should be included. Users may create their own C3E values and use them instead of the default values.

The effect of communications on combat is modeled extensively and appropriately; however there are still some occasions in the game when connectivity should be a factor but checks are not included. More could be added easily. Time delays are not directly modeled in the game; however, since the time step of the Operations Phase of the game is a whole day, time delays would be difficult to model.

The role of the Airborne Command Post in combat is minimized in the game. It's only role is as a communications relay. There is no use of the ABNCP as an

alternate decision-making unit, in case of combat losses at the Joint Task Force Headquarters.

The Airborne Warning and Control Aircraft acts as a communications relay and also provides advanced warning of air strikes. AWACS should also add to the effectiveness of counter-air and close-air-support. It could also provide some additional tactical intelligence.

The combat models are low-resolution, simplistic models. They are based almost entirely on input combat values. These values should be evaluated by people with combat experience to make sure the values for different units have realistic ratios. However, the simplistic models themselves may be sufficient, since the purpose of COMEL is to train communications officers, not combat operations officers.

The implementation of the enhancements listed in Chapter IV could eliminate most of the known deficiencies of the game.

III. USE OF COMEL

COMEL was developed as a manual game to train communications staff officers. The computer version can be used for this purpose at TSSOC, in the Telecommunications Management curriculum at the Naval Postgraduate School (NPS), or wherever a compatible computer capability exists. By forming into joint staffs and discussing the advantages and disadvantages of various communications systems in the game scenario, students and other communications officers can apply what they have learned about systems, the acquisition process, and the role of communications in supporting combat. The major learning experience for communications officers comes in discussions during the Acquisition Phase of the game and during the first Operations turn, while allocating the equipment to units and missions. The remainder of the Operations Phase serves to provide feedback, helping players to evaluate their decisions. The combat phase also makes playing the game much more interesting!

For students in the Command and Control curriculum or in Operations Research at NPS, the game provides a demonstration of the interrelationship of air and land combat and the roles of communications and electronic

systems. The game also provides a convenient format for students to learn simulation and war gaming techniques. Unlike most computer war games, COMEL is specifically designed for study and modification by novice programmers. Students with only a rudamentary knowledge of FORTRAN can study the construction of the models, evaluate and criticize them, and try to improve them.

The Acquisition Phase of COMEL can be used to demonstrate some of the material learned in project management courses. The Acquisition Phase illustrates the steps in the system life cycle and gives an appreciation of the time necessary to procure a system. The decisions and timing also show some of the concepts studied dealing with the Five Year Defense Plan and the Planning, Programming and Budgeting System.

If properly validated (see Chapter V, Section A) the game might be used by serious researchers to study various measures of effectiveness for command and control systems. The same scenario can be run using different measures of effectiveness for component systems. The relative value in combat of two different systems, for example an additional AWACS or new HF radios, could be evaluated by giving one to the Red forces and one to the Green, with all other factors the same. Measures of effectiveness for the overall command and control process could be evaluated by seeing how well they predict the outcome of the game.

IV. RECOMMENDED ENHANCEMENTS

The modular construction of the game lends itself to the addition of many enhancements which could be accomplished as individual or group projects. This section of the thesis describes some but not all of the enhancements that could be made.

A. VALIDATION OF OPERATIONS MODELS

The models used in the Operations Phase and the numerical values assigned are primarily those developed for TSSOC's manual version of the game. If the numbers and models were validated the game could be used as more than a training aid. The critical points to be validated are:

a. The C3 effectiveness values for default communications and electronic systems.

b. The relative combat values of units, including ground combat value, air defense value, and various air combat values.

c. The effect of terrain on communications.

d. The effect of terrain on movement.

e. The combat outcomes table, air defence outcomes, and counter-air outcomes.

The single most critical factor in the game is the C3 effectiveness value for communications and electronics systems. This number, as developed by the designers of the game, is a direct product of reliability, flexibility, and operability (see Chapter 2, Section C). These values, if they are to be used, should be verified as typical of the particular type of equipment. However, there may be a better measure of effectiveness than this product. Perhaps a different weighting of the factors should be used or perhaps new factors should be added. Since time delays are not directly modeled, perhaps a measure of speed of transmission or speed of message preparation should be added. Different measures of effectiveness can be used for different systems. As long as the final C3E value is expressed as a probability, any value may be used and the game can proceed with no changes except to the initial data file.

The game models might be validated in five ways:

a. Each individual model such as close air support or terrain effect on movement could be subjectively analyzed by experts in the field.

b. The scenario could be modified to match that of a higher resolution game such as the McClintoc Theater Model (MTM) [Ref. 3], and the final results could be compared.

c. The scenario could be changed to match a historical battle of similar scope, such as the Faulkland

Islands or the 1982 Lebonese conflict, and the game result could be compared to the actual outcome.

d. The scenario could be changed to match that of a field exercise and the outcomes could be compared.

e. Some of the individual models could be compared to real world situations. For example, a game combat unit and Joint Task Force Headquarters could be given exactly the same set of communications equipment as is available to a real world unit and its headquarters. The game units could be set in map terrain to match the actual situation. The real capability to get messages from the unit to the headquarters could be measured through test messages and compared to the game unit's ability to communicate with headquarters (C3EXT).

The validation methods described here could easily become the subjects of several different theses. One thesis could develop and test a better method of calculating C3E for the systems. In another thesis, a communications student could analyze the communications models, NCACON, INTC3, and C3EXT, and their effect on the battlefield. An Electronic Warfare student could analyze the EW models. A Command and Control or Operations Research student with extensive air-land combat background could analyze the combat models.

B. GRAPHICS

The computer version of COMEL still requires manual layout of communications networks to plan the allocation of equipment. A graphics program that took the list of equipment and proposed allocations and drew the resulting networks would be a valuable enhancement of the game. The graphics program could use color to distinguish between fixed and mobile equipment. It could call on Subroutines NCACON, INTC3, and C3EXT to calculate the overall connectivity measures for each unit and display them so the player would know which units needed more equipment for good connectivity.

The game also requires a manual game board. The players and the Umpire maintain separate maps of their view of the battlefield. A graphics program could be developed to display the map at two levels of detail. A complete map could show all the owned units' locations and perhaps their proposed paths and any known enemy locations. A higher resolution map could be called up to show hex coordinates and possibly combat values. The development of these graphics features would be a thesis scope project.

C. SOFTWARE CONTROL ENHANCEMENTS

A program needs to be developed to build the system data and associated compatibility tables with full error checking and editing capabilities built in. Interactive modules

could also be designed to help the user lay out new maps or combat results tables. (Unit and equipment lists already can be developed interactively.)

D. ACQUISITION PHASE ENHANCEMENTS

More decision aids need to be developed for the Acquisition Phase. These could include a routine to optimize the force effectiveness using linear programming and sensitivity analysis. The constraints would be the money available and the year necessary for deployment. Also this routine could give a forecast of the budget required in a five year acquisition plan.

The equipment procured in the Acquisition Phase is not presently screened against the forces to be supported. A decision aid that used the Subroutines C3EXT, INTC3, and NCACON to cross check equipment versus the forces supported could show the adequacy or inadequacy of planned acquisitions.

E. OPERATIONS PHASE ENHANCEMENTS

A history module could be developed to prepare a printed record of the game. Locations, goals, targets, combat values, etc. could be derived from the blackboards and formatted at the end of each player turn and at the end of the combat sequence. During each turn, selected status

reports or player inputs could trigger matching write statements to the history file.

New scenarios could be developed, perhaps matching some real world situation such as the Persion Gulf. A new map and new unit and equipment lists could be developed to match the real world as closely as possible.

New equipment types, such as laser communications, satellite jammers, or airborne EW, and new unit types, such as ground recon units, could be added to the models.

The game already allows communications or EW equipment to be set up as separate mobile detachments. A module could be added to allow such a detachment to be merged back into a combat unit.

Intelligence satellites and reconnaisance flights give the location of enemy units. The module could be modified to give the type of unit (perhaps only designating it as an airfield, heqdquarters, light or heavy combat unit). The direction of movement could be derived from the goal or projected path and indicated by an approximate compass direction. The probability of detection could be varied according to the terrain or a random factor.

In a conflict situation, a commander could be given the option to pursue an enemy unit as it retreats or moves on toward its goal.

A change in the rules of engagement is immediately and automatically known to both players. A communications check between the NCA and the JTFHQ could be added before the change would take effect.

A new rule of engagement could be designed to allow commanders of major units, such as the carrier battle group, to attack on their own while requiring other units to check with the JTFHQ.

In the COMM1 modules, where equipment is allocated to missions and combat units, "idiot checks" could be added to echo each choice and provide for review and revision at the end of the module.

The intelligence module could be expanded to include general, all-source intelligence.

A greater degree of uncertainty could be included at the Umpire's request by adding random "Murphy cards", as are used in the manual game.

The line-of-sight probability model [LOSPRB] could be modified to allow more than one relay point between the unit and the JTFHQ.

An ECCM mode could be added for EW equipment.

The optimum path routine and other modules could be made more efficient.

Presently the lakes and rivers are not navigable. Changes to Subroutine PNTS could allow the amphibious task forces to navigate the rivers and lakes.

The air reconnaisance missions and airdrops are executed without any counter air or air defense opposition. These modules could be revised to include calls to the counter air module and resolution of air defense.

A Logistics Phase could be added to allow systems that are still in the R+D or M+D stages of Acquisition when the war starts to be brought into operation during the Operations Phase if proper logistics planning has been done. The Logistics Phase could include purchase and scheduling of strategic airlift. Planning for maintenance could be made to affect availability or effectiveness of systems.

V. GAME PLAY REQUIREMENTS

A. HARDWARE REQUIREMENTS

COMEL was developed on a Digital Equipment Corporation VAX 11/780. The operating system used is VMS. (VAX stands for Virtual Address Extension and VMS stands for Virtual Memory System.) COMEL can be run on any other system that supports FORTRAN-77 and has some type of command file executive.

The game requires three terminals; one for the Umpire and one each for the Red and Green staffs. Because of the numerous displays printed, the baud rate (speed of transmission) should be a least 1200.

The game can be played over dial up telephone connections. Telephone Modems are readily available for tranmission at this baud rate. If possible, it is more convenient to have dedicated terminals with direct connection to the host computer (these connections should also be at least 1200 baud).

Any type of terminal can be used to run the war game. The game is written to support terminal types of a generic nature. The only terminal I/O commands used are write, read, accept and type. There are no unique commands specific to a terminal type. If a hardcopy terminal is

used, the paging command may waste paper since it prints 24 blank lines. If a terminal supports a display of less than 24 lines, some messages and menus may be cut short.

B. SOFTWARE REQUIREMENTS

The VAX/VMS operating system [Ref. 4 and 5] must be used to run COMEL game as written. The software packages required are the VAX/VMS command file interpreter and VAX-11 FORTRAN (FORTRAN-77) [Ref. 6 and 7].

Conversion to other computer systems with different operating systems, but with some dialect of FORTRAN-77, would require only minor adjustments in the programs (ie, mostly input/output routines such as open, close, type and accept). A majority of systems have some form of command file interpreter. However, the command file program would have to be transposed line by line to the new system because of the uniqueness of commands on different operating systems.

Conversion to other computer systems with different operating systems and standard FORTRAN (FORTRAN-4) would be a major project. Standard FORTRAN does not include constructs such as 'IF...THEN...ELSE' or 'DO WHILE...END DO' or character type variables. In conversion to standard FORTRAN, all the programs would have to be checked line by line and rewritten wherever non-standard FORTRAN is used. While difficult, the conversion could be accomplished.

COMEL is written (as much as possible) in structured FORTRAN in a top down approach. Maintainability and readability were prime considerations in the development of COMEL.

C. PHYSICAL REQUIREMENTS

In addition to the computer requirements discussed above, the following physical materials are needed to play the game: game boards with unit markers, scenario and mission descriptions (Operational Plans and Commander's Assesments used for the default game are attachments to the Users' Manual), and copies of the Users' Manual.

COMEL is more instructive when the Umpire, Red Players and Green Players are physically seperated. Therefore, the game should be played in three seperate rooms. The Umpire and players should have seperate maps, since the players have complete information on their forces but only partial information on their opponents.

Users' Manuals should be available to the players and umpire. COMEL requires that the Umpire and players have a good advance knowledge of the Users' Manual, which describes all the options available to the Umpire and players and the effects of each option.

The Maintenance Manual is not essential for game play but will be useful if anyone wants to know more about the models or wants to modify the game. A detailed outline of how the program is constructed can be found in the

Maintenance Manual, as well as the basic logic of each module and the parameters used by each routine. Information desired on the computer system can be found in one of the DEC Manuals; the VAX/VMS Primer [Ref. 8], VAX/VMS Command Language Users Guide [Ref. 5] and the VAX-11 FORTRAN Language Reference Manual [Ref. 6].

LIST OF REFERENCES

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3. McClintoc Theater Model, Vol II, User's Manual, Department of War Gaming, US Army War College, Carlisle Barracks, Pennsylvania, 1981.

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5. Digital Software, VAX/VMS Command Language User's Guide, (Order No. AA-D023C-TE) Digital Equipment Corporation, Maynard, Massachusetts, 1982.

6. Digital Software, VAX-11 FORTRAN Language Reference Manual, (Order No. AA-D034C-TE) Digital Equipment Corporation, Maynard, Massachusetts, 1982.

7. Digital Software, VAX-11 FORTRAN User's Guide, (Order No. AA-D035C-TE) Digital Equipment Corporation, Maynard, Massachusetts, 1982.

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9. Dijkstra, E.W., "A Note on Two Problems in Connection with Graphs", Numerish Mathematik, Vol I, p.269-271, 1959

APPENDIX A

COMEL USERS' MANUAL

FIGURES

ATTACHMENTS

1. INTRODUCTION

1.1 THE GAME

The purpose of Communications Electronic War (COMEL) is to allow students in communications, command and control, or related disciplines to exercise their knowledge of electronic system capabilities, the planning and acquisition processes, and the employment of communications and electronic systems in combat. Although the game does not attempt to model the exact, real time operation of the communications and electronic systems; it does attempt to realistically demonstrate the effect of electronics on the modern battlefield.

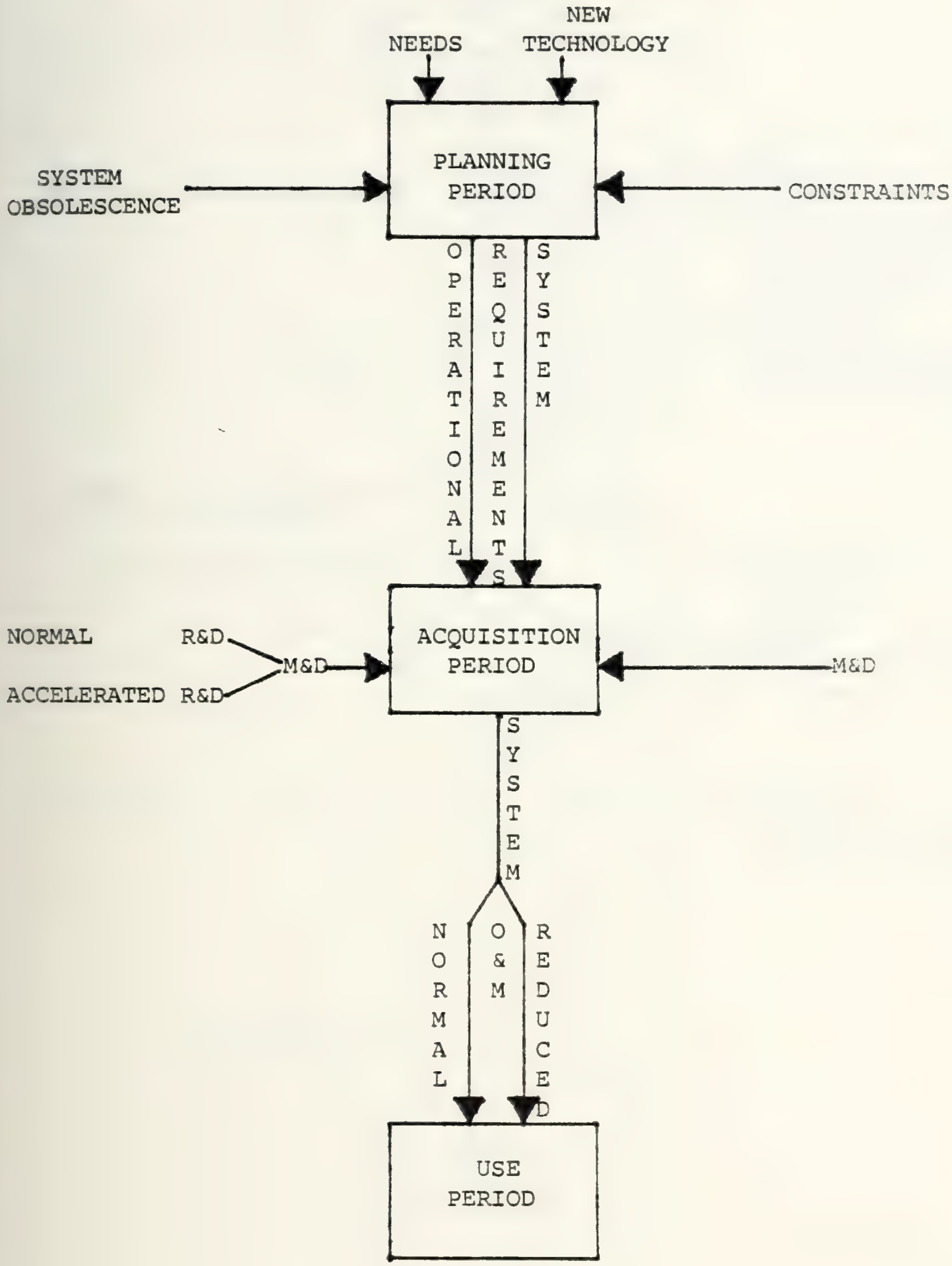
This manual gives detailed instructions for the Umpire and the players to run the game. A Maintenance Manual is also available (Appendix B) for anyone who wishes to study the construction of the models or modify the game. The main body of the thesis describes the background, uses of the game, and major models, and proposes future enhancements.

The game has two phases, an Acquisition Phase and an Operations Phase. Either may be played separately or in sequence. The game may be played in one sitting or may be saved at the end of any turn and resumed at a later time.

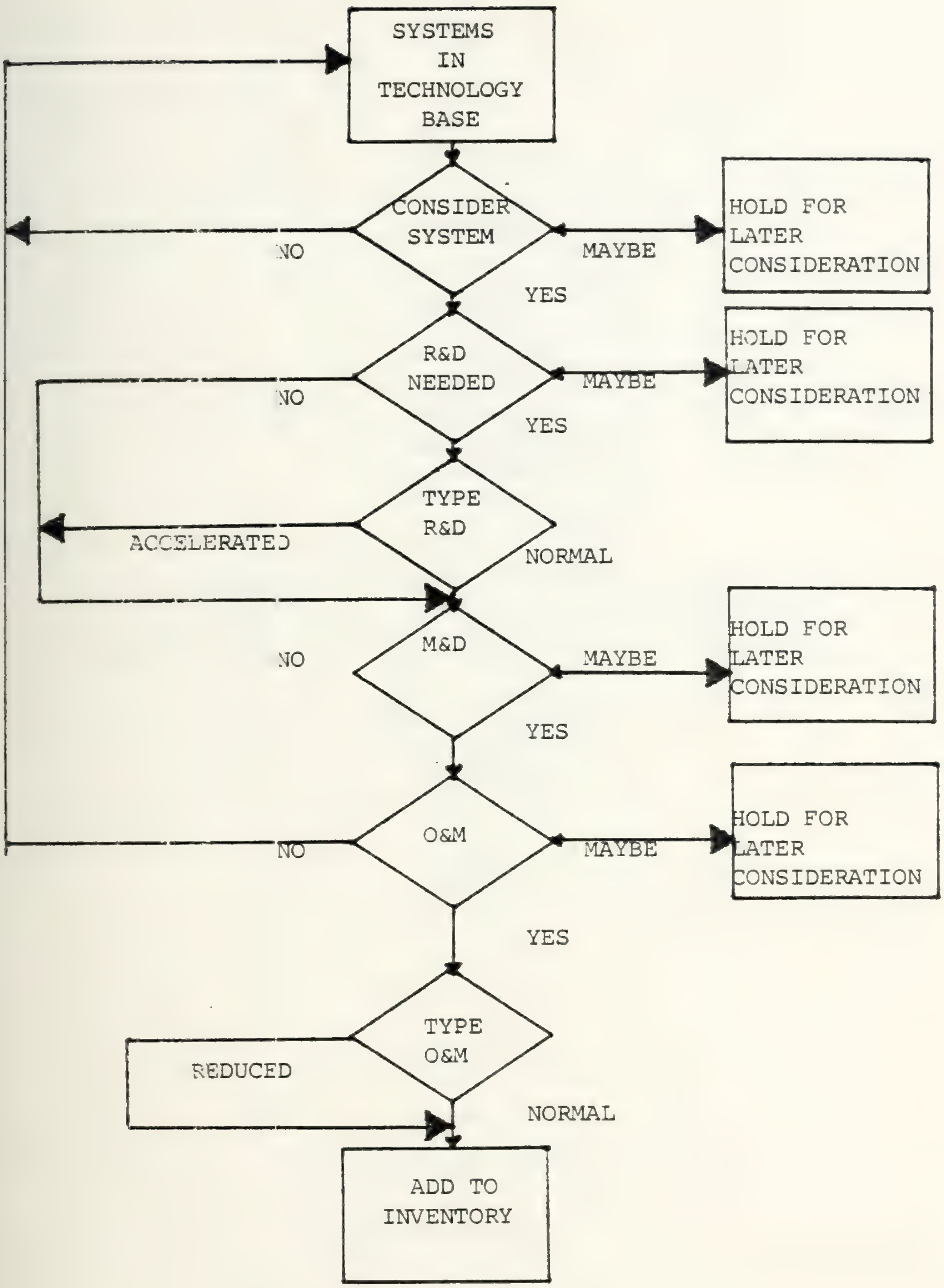
In the Acquisition Phase, players budget under time constraints for research and development, manufacturing, purchase, and operations of communications and electronic equipment for a Joint Task Force (JTF). This phase of the game traces the life cycle of electronic systems, as illustrated in Figure A-1. [Ref. 6]

In the Operations Phase, players allocate the available communications and electronic equipment to units, physical locations, or special missions and then direct the employment of the units and equipment in a war game. The war pits two approximately equivalent JTFs against each other in a race to gain control of major and minor objectives. The relative capabilities of the two sides are affected greatly by the acquisition, allocation, and employment of their electronic equipment.

Figure A-2 is a simple diagram of the sequence of the Acquisition Phase. Figure A-3 is a diagram of one turn of the Operations Phase. Figure A-4 shows the sequence of a complete, two phase game. The initial conditions of the war may be changed as different maps and objectives, different communications and electronic systems, different units, or different equipment lists are used. However, the basic sequence of the game stays the same.

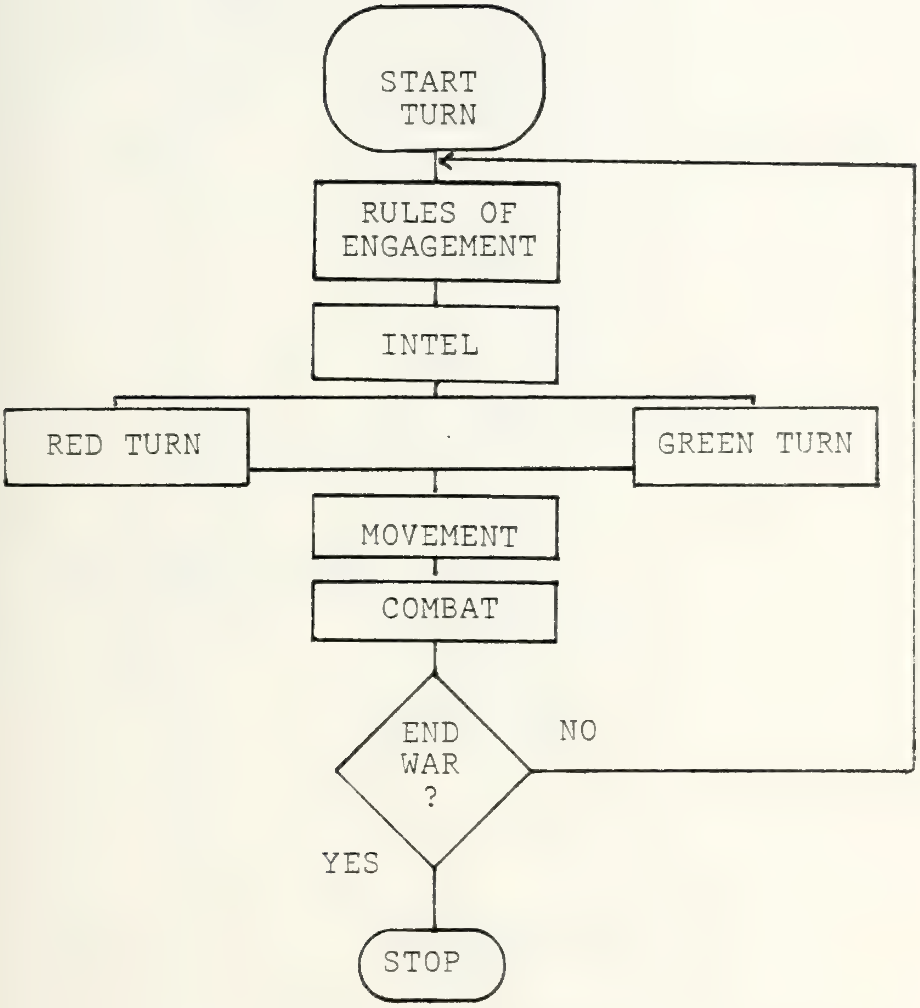


SYSTEM LIFE CYCLE
FIGURE A-1



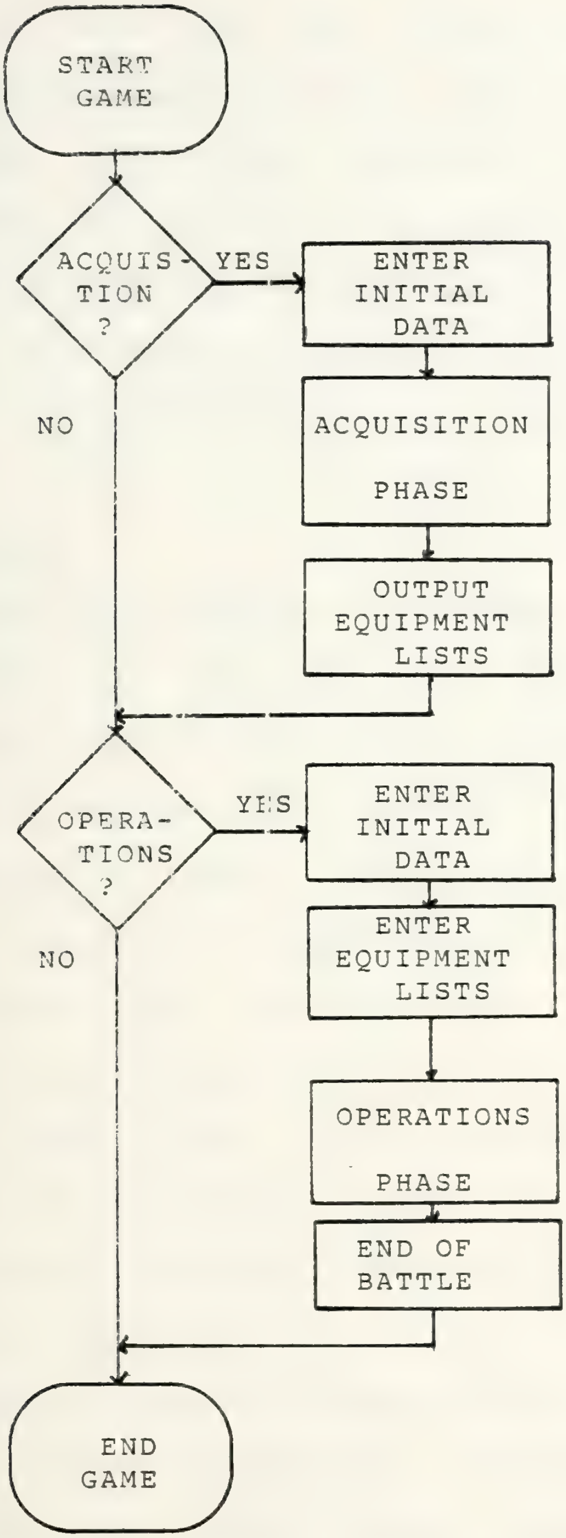
ACQUISITION SEQUENCE

FIGURE A-2



THE OPERATIONS TURN

Figure A-3



GAME SEQUENCE

Figure A-4

Instead of creating a map, objectives, communications and electronics systems, and unit lists unique to each game, a default game is provided. Detailed information on the default game may be found in Section 2 of this manual. Information on game play can be found in Sections 3 and 4. Procedures for preparing alternate versions of the game can be found in the Maintenance Manual.

1.2 THE PLAYERS

COMEL has three computer positions; the Umpire, the Green Player, and the Red Player. However, each position can and should actually be more than one person.

The Umpire has two roles. First, the Umpire controls the sequence of the game by setting the time limits for each turn and by selecting the game version to be played; for example, three turns of Acquisition using the default communications and electronics system lists, followed by ten Operations turns using the default map but alternate unit lists. Second, the Umpire takes an active role in the game play by making decisions that would normally be made at command levels above the JTF; for example, setting the annual budget for communications and electronic systems, and setting the rules of engagement. The Umpire should ideally be more than one person, since group decision making discussions provide a better learning experience.

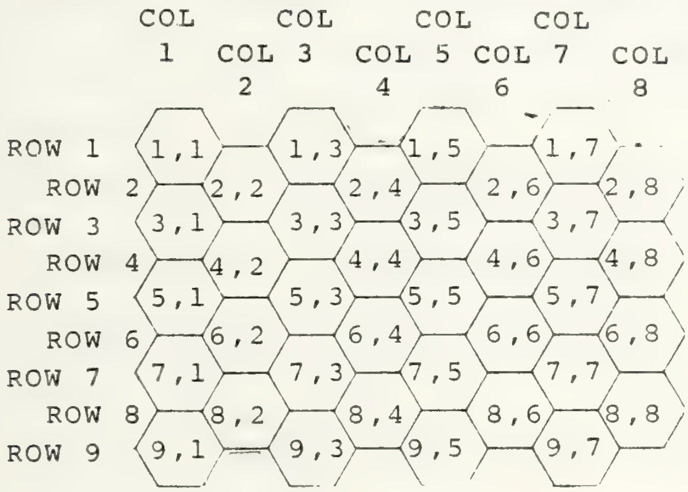
In the Acquisition Phase, the Red and Green Players act as the C3 planning staffs for their respective JTFs. During the Operations Phase they act as both the JTF staff and the direct operational commanders. Each side should ideally have at least six people: a JTF commander, a communications officer, an air support advisor, a naval-marine advisor, and two or more land combat operations advisors (who would also represent the combat unit commanders).

1.3 THE GAMEBOARD

The gameboard consists of a map translated into hexagonal divisions, hexes, in 66 rows and 60 columns. Each hex represents an area approximately five miles across, and may be designated as either open terrain, desert, mountains, woods, lake, or sea. Roads may be shown running through the hexes; rivers flow along borders between the hexes. Also located on the map are permanent features such as cities, airfields, forts, mines, major industries, or ports. The default map is illustrated in Attachment A-1 at the end of this manual. Procedures for preparing alternate maps are described in the Maintenance Manual.

The map numbering system is critical to play of the game, since players must frequently indicate locations of units, movement goals, targets, etc. by giving the hex coordinates. Hexes are numbered in rows and columns;

the row number is given first and then the column number. A segment of a hex map is shown in Figure A-5.



MAP NUMBERING SYSTEM

Figure A-5

The rows seem to alternate, with even rows staggered to the right of odd rows. This results in each hex having either two odd coordinates, like 3,5 or two even coordinates, like 4,6. No hex could be numbered 4,7 since one number is odd and one even. Hex coordinates may be entered at the terminal by separating them with either a blank space (3 5) or a comma (4,6). If counting hexes on the map, count columns by ones and rows by twos.

1.4 THE GAME PIECES (SYSTEMS AND UNITS)

The game pieces for COMEL consist of red and green markers for the units, which are moved around the map manually as the game proceeds. Symbols representing the equipment items may also be used, but that information may be kept only on paper.

Any number of units up to 19 can be entered into the game, but all units must be classified as one of eight types:

(1) Joint Task Force Headquarters (jtfhq)
(2) Tactical Fighter Wing (tfw)
(3) Carrier Battle Group (cbg)
(4) Amphibious Task Force (atf)
(5) Marine Amphibious Brigade (amph)
(6) Armored Brigade (armor)
(7) Mechanized Brigade (mech)
(8) Airborne Brigade (abn)

During the game, players may also establish communications or electronic warfare detachments ('relay' is used for the unit type in either case).

Each unit has assigned to it certain combat values. The basic combat points of a unit, CMBTP, are a measure of its ground combat capability. Each unit also has an air defense capability, ADNO. Air units (tfw and cbg) have assigned measures of their ability to overcome enemy air defenses, EWV, to give close air support, CASV, and to conduct air-to-air combat, CAV. These values are all entered as part of the initial data files.

The game will handle up to 49 different communications and electronics systems and up to a total of 99 individual end items of equipment.

Any lists of communications and electronic systems can also be used, but each individual system must be classified as one of twelve types:

(1) Tactical systems (tac)
(2) High frequency systems (hf)
(3) Line-of-sight systems (los)
(4) Communications satellites (sat)
(5) Satellite ground terminals (gtsat)
(6) Very low frequency systems (vlf)
(7) Switches (sw)
(8) Airborne command posts (abncp)
(9) Airborne radar (awacs)
(10) Electronic warfare systems (ew)
(11) Intelligence satellites (spy)
(12) Anti-satellite weapons (asat)

1.5 THE DEFAULT GAME

A default game has been developed based on the original, manual version of COMEL. The entire default game may be played or some or all of the data files may be replaced by alternate files. See the Maintenance Manual for instructions on building alternate files.

1.5.1 <u>The Map</u>

The default map, pictured in Attachment A-1, features Red and Green Joint Task Forces located in airfields and forts in two of their allied countries, Yellow Country and Blue Country. Between them is a neutral country, Utopia. Utopia has valuable mineral resources in

their Southern Mines, which they transport along a main highway and export through the Port of Utopia. The objective of each task force is to try to gain control of the mines, the port, and the connecting highway before the other side does. A player is considered to have control of a hex if a unit from that side was the last unit in the hex. The mines and port are considered major objectives; the road is a minor objective. Between the two sides' initial locations and their objectives lie similar terrain of mountains, woods, deserts, and lakes.

1.5.2 <u>The Systems</u>

The default game has thirty eight different communications and electronic systems of the twelve types listed in Paragraph 1.4 above. These systems are listed in Attachment A-2 with their associated technical and cost data. General descriptions of the twelve different system types are in Attachment A-3.

1.5.3 <u>The Units</u>

Each side in the default game has equivalent forces. The units, their initial locations, mobility, and combat values are listed in Attachment A-4.

1.5.4 <u>The Equipment</u>

The equipment lists include each individual end item acquired by a player. Two sets of default equipment lists are available. One set is designed for use in the Acquisition Phase and includes a very rudimentary set of

older equipment. The players use these lists as a base on which to build an adequate communications and electronic capability for the projected threat. The second set of default lists is designed for use when playing only the Operations Phase of the game. This set provides fairly adequate capabilities for the default forces. These lists can be found in Attachments A-5 and A-6.

1.5.5 The Operations Plans

Printed Operations Plans and Commander's Planning Guidance are also available for the default game. These documents define for the players the threat and their objectives. They give general operational guidelines, such as would be developed for real world contingency plans. These documents are Attachments A-7 thru A-10 of this manual.

2. COMMUNICATIONS AND ELECTRONIC EFFECTS

This section of the manual discusses the C3 measures of effectiveness (MOEs). Some of the measures are used by the player during the Acquisition Phase to determine the right mix of equipment to purchase. The measures are used by the computer models in the Operations Phase to compute the effect of communications and electronics systems on the battlefield.

2.1 MEASURES OF EFFECTIVENESS

Electronics capability in the game is based primarily on a measure called "C3 Effectiveness", which is a real number between 0.0 and 1.0 assigned to each communications system and most other electronic systems. In the default game, the C3 effectiveness (C3E) is a product of reliability, flexibility, and operability of the system. For communications systems the square root of the product is then taken to represent the C3E of one end of a comm link. (See thesis Chapter II, Section C.) In alternate games other measures of effectiveness could be developed and used in the system data files.

The effectiveness of a system can be affected by terrain. After each move the computer program checks the location of all equipment to see if it is effected by terrain. The affects of terrain are shown in Figure A-6.

TERRAIN TYPE	COMM SYSTEM TAC	HF	LOS	SAT
Open	none	none	none	none
Desert	Degrades all systems 20%			
Woods	1/2 Range	Degrades GW 20%	none	none
Mountains	Range 1 hex	Degrades GW 40% SW 20%	Note 1	none
Seas/Lakes	Degrades 15%	Degrades 20%	Degrades 15%	none
Cities	Degrades 20%	Degrades GW 40% SW 20%	Degrades 15%	none

GW = HF in Ground Wave Operation
SW = HF in Sky Wave Operation

Note 1: LOS transmission is degraded by mountains in the path. The model uses the optimum path to simulate line-of-sight and checks the path for mountain hexes. Two or more hexes located less than three hexes from the unit's end of the path will block LOS links completely. If the mountains are three hexes from the end they will degrade the link 25%

TERRAIN EFFECTS ON COMMUNICATIONS

Figure A-6

The effectiveness of a system may be affected by enemy jamming. Prior to combat, the program checks any electronic warfare equipment in the Electronic Countermeasures (ECM) mode to see if it is in range of any enemy communications gear that it is effective against. If so, the C3E of the communications equipment is muliplied by a factor of 0.75.

Communications connectivity of units is calculated in three functions, based on the C3E of collocated equipment:

(a) INTC3 is a measure of a unit's ability to communicate internally. The value depends primarily on the effectiveness of the tactical communications equipment assigned to the unit. If n items of tactical equipment are assigned to a unit, the unit's INTC3 is calculated as:

INTC3 = 1 - [(1 - C3E(1))*(1 - C3E(2))*...(1 - C3E(n))]

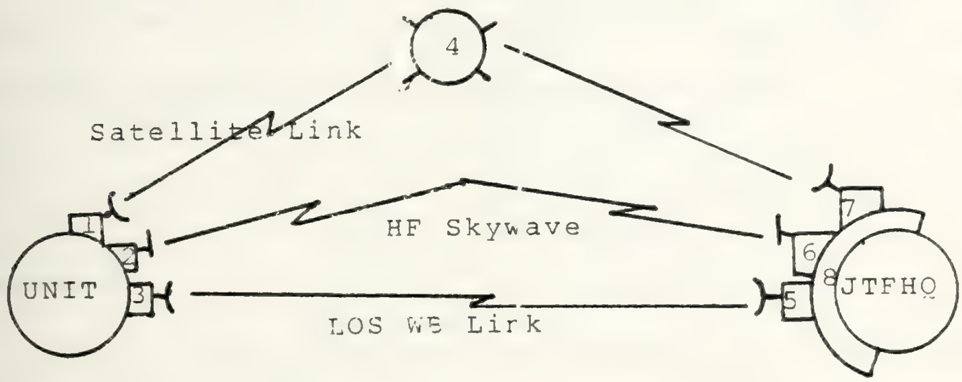
The higher the internal communications value, the faster a unit can move and the better it can fight.

(b) C3EXT is a measure of a unit's ability to communicate with the Joint Task Force Headquarters. Links can be established through satellites, through HF (either ground wave or skywave depending on range), through line-of-sight systems (in direct range or through one relay), and even through tactical systems (only at very close range). For a link to be effective, both the unit and the JTFHQ must have compatible equipment. Some equipment is compatible only if located in the same hex or if connected by wire within the same hex. (See Attachment A-2f.)

The basic formula for calculating C3EXT is:

C3EXT = 1 - [(1-HFPROB)*(1-GTPROB)*(1-LOSPRB)*(1-TACPRB)]

These probabilities are products of the C3E of systems in the link. HFPROB is the probability of an HF link, GTPROB of a satellite link, LOSPRB of a line-of-sight link, and TACPRB of a tactical link. The communications links for a typical unit are shown in Figure A-7, along with calculation of its C3EXT. The C3E values are from the default game.




```
   DIAGRAM NUMBER        EQUIPMENT     C3E
--------------------------------------------------------
Equipment #3 and #5    -   wb 1     -  c3e = 0.787
Equipment #2 and #6    -   hftty 1  -  c3e(sky wave) = 0.608
Equipment #1 and #7    -   shf-gt   -  c3e = 0.819
Equipment #4           -   shf-sat  -  c3e = 0.67
Equipment #8           -   tritac   -  c3e = 0.95
--------------------------------------------------------
              LINK PROBABILITIES
--------------------------------------------------------
LOS Link Probability   = #8 * #3 * #5 = .588
HF Link Probability    = #8 * #2 * #6 = .351
Satellite Link Prob.   = #8 * #1 * #4 * #7 = .427

C3EXT = 1 -[(1-.588)(1-.351)(1-.427)] = 0.847
--------------------------------------------------------
```

CALCULATION OF EXTERNAL C3 EFFECTIVENESS

Figure A-7

(c) NCACON is a measure of the JTFHQ ability to communicate with the National Command Authority (NCA) or any other CONUS based unit via satellite, HF, and/or VHF links. Its computation is similar to C3EXT except the NCA is assummed to have 100% effectiveness in VLF, HF, and satellite ground terminals. Only certain communications systems are compatible with NCA systems. The players must purchase and/or allocate communications systems effectively to get good values for all three of these communications measures (INTC3, C3EXT, AND NCACON). These three measures affect many aspects of the Operations game, as described below.

2.2 MOVEMENT

A unit will not begin to move across the game map, or change the goal (destination) of its movement unless ordered to do so by the JTFHQ. To determine whether a movement order can get to a unit, the unit's C3EXT is compared to a uniform (0,1) random number.

Each unit has a basic number of movement points per turn, based on the type of unit (armor, infantry, headquarters, etc.). This movement rate is initially set in the data files but can be reduced by terrain; for example, movement through mountains takes more points (3) than movement through open terrain (1), but roads allow faster movement (1/2). The movement rate is also affected by the

mobility of any electronic equipment the unit is carrying along with them. If any communications or electronic equipment the unit is carrying has less mobility than the unit, the unit must slow down. Poor internal communications can also slow down unit movement. The INTC3 value of the unit is compared to a random number; if the random number is larger the movement points of the unit are reduced by a half. (See Figure A-6 in Section 2.6 for details of the terrain effect on movement points.)

2.3 INTELLIGENCE

Intelligence satellite information cannot be passed to the JTFHQ unless there is connectivity from the CONUS (NCACON). Air reconnaissance requires connectivity from the JTFHQ to the air wing (C3EXT).

2.4 ATTACK APPROVAL

The Umpire, acting as the NCA, selects the rules of engagement at the beginning of the Operations Phase and can change them during the game. There are three levels of engagement: the NCA may retain tight control of the war, may delegate authority to the JTF Commander, or may give control to local field commanders. For example the NCA or JTF may want to maintain attack approval to ensure that the other side initiates hostilities, or to coordinate the timing of a preemptive, force-wide attack.

The NCA does not delegate control of the anti-satellite weapons. If the NCA retains control, connectivity from the unit involved to the JTFHQ and to the NCA is checked for every decision to attack, on the ground or from the air. If control is delegated to the JTF Commander, only unit-JTFHQ connectivity is checked before an attack. If the local commander has control, connectivity is necessary only for air support.

Approval level is determined and necessary communications checks made before anti-satellite firings, interdiction missions, or ground attacks begin. (Close air support, air defense, and counter air missions occur only in conjunction with interdiction or ground attacks, and so are also dependent on the rules.)

2.5 THE AIR BATTLE

Close air support and interdiction missions require connectivity to the air wing and internal communications for the wing. Counter air requires good internal communications within the air wing. If the enemy unit has AWACS, counter air interceptors are warned in time to attack interdiction or close air support missions enroute; without AWACS the interception takes place after the support mission is completed.

Counter air battles are resolved by subtracting the counter air values (CAV) of both sides and comparing the difference to a random number. An internal table, based on the one in Figure A-8, determines the outcomes.

		GREEN CAV - RED CAV								
		4	3	2	1	0	-1	-2	-3	-4
	0	GL	GL	GL	GL	GL	GL	GL	GL	GL
R N	1	-	G	GL	GL	G	GL	GL	GL	GL
A U	2	X	-	G	G	G	GL	GL	GL	GL
N M	3	R	X	-	-	-	G	GL	GL	GL
D B	4,5	RL	R	R	X	X	X	G	G	GL
O E	6	RL	RL	RL	R	-	-	-	X	G
M R	7	RL	RL	RL	RL	R	R	R	-	X
	8	RL	RL	RL	RL	R	RL	RL	R	-
	9	RL	RL	RL	RL	RL	RL	RL	RL	RL

- Standoff; Both sides continue mission
X Both sides abort missions
R Red aborts
G Green aborts
RL Red aborts with attrition
GL Green aborts with attrition

COUNTER AIR RESULTS TABLE

FIGURE A-8

Close air support (CAS), if not stopped by the counter air forces, subtracts the air wing's electronic warfare value from the ground unit's air defense value. The difference and a random number are compared using the table in Figure A-9 to determine the outcome. If the CAS mission is not aborted, the ground unit's combat value is reduced by 1.0.

AIR DEFENSE VALUE - EW VALUE
(Ground Unit) (Air Unit)

RANDOM NUMBER	1	2	3	4	5
0,1	N	N	N	N	N
2,3	N	N	N	N	A
4,5	N	N	A	A	AA
6,7	A	A	A	AA	AA
8,9	A	AA	AA	AA	AA

N = No effect
A = Aircraft abort mission
AA = Aircrift abort with attrition

AIR DEFENSE RESULTS TABLE

Figure A-9

Interdiction missions also must go through counter air and air defense battles, as described for CAS. If the mission is not aborted, the ground unit's combat value is also reduced by 1.0.

2.6 THE GROUND BATTLE

Each ground unit has a certain ground combat capability that may or may not have been reduced by interdiction or close air support. Higher headquarters approval may be needed for a ground attack (NCACON and C3EXT). Poor tactical communications may decrease the ability of a local commander to direct the movement and other actions of his

forces during the battle (INTC3). Terrain also affects combat capability as shown in Figure A-10.

TERRAIN TYPE	MOVEMENT COST IN MOBILITY POINTS	COMBAT EFFECT IN COMBAT POINTS
Open	-1	none
Highway	-1/2	none
Desert	-1	+1 for attacker
Woods	-2	+1 for defender
Mountains	-3	+2 for defender
Seas	-1 (ships only)	none
Lakes	-999 (no movement)	none
Rivers	-1 (when crossing)	+1 if defending behind
Cities	-1	+1 for defender

TERRAIN EFECTS ON MOVEMENT AND COMBAT

Figure A-10

2.7 ELECTRONIC WARFARE

Electronic warfare equipment may be used in two modes, ESM (Electronic Support Measures) and ECM (Electronic Counter Measures). In the ESM mode, it can give bearings to compatible enemy emitters, as intelligence information, improving planning and local combat direction. In the ECM mode it can jam or deceive susceptable communications, degrading the effectiveness of enemy systems. In ground

combat, equipment in the ESM mode can detect and possibly intercept or deceive enemy communications. If so, the owning unit's combat points are increased by the EW factor of the equipment.

2.8 SPECIAL EQUIPMENT

Special equipment, such as satellites, anti-satellite weapons, AWACS, and Airborne Command Posts can greatly increase the capabilities of the combat forces through intelligence, communications relay, or by degrading enemy capabilities.

Communications satellites are of two types, those with one area beam and those with several spot beams. Ground terminals that are compatible are always in range of area beam satellites. However, when using spot beam satellites, the players must reposition the spot beam centers so that the ground terminals can use the satellite.

Intelligence satellites survey a north-south strip of the map. The width of the strip depends on the beamwidth of the satellite. The columns to be surveyed can be changed once each turn. The effectiveness (C3E) is less than 100% (there may be cloud cover or the satellite may not be working), but when the satellite is working it detects any enemy unit in the strip it surveys.

Anti-satellite weapons can only be used once, against either a communications or an intelligence satellite. Only one weapon may be used in a turn. Each weapon has a given C3E. If the NCA approves the use of a weapon, the C3E and a random number are used to determine whether the attack is successful.

AWACS and ABNCP operate on scheduled rotations. No more than one of each is in orbit for a turn. If less than three of each were purchased, they may not be available at all times. If they are available, and don't break down at the last minute, their orbit can be set for each turn. They can act as communications relays and the AWACS can detect interdiction and close air support attacks and call up counter air to stop them.

3. UMPIRE GAME PLAY

3.1 INTRODUCTION

This section describes COMEL from the Umpire's perspective and lists the possible options and their consequences to game play. Section 4 describes the game in the same way from the Green and Red Players' perspective.

The following subsections describe:

a. The procedure used to LOGIN on the VAX/VMS computer and start COMEL.

b. The steps the Umpire should follow to successfully setup and run various versions of COMEL.

The Umpire is an active participant in COMEL and not just an observer. An amount of preplanning is necessary to ensure a smooth and well run game. The Umpire should plan for how long the total game will take and divide the game turns accordingly. It might be necessary to play the game over a period of more than one day or at least in more than one session at the terminal. The Umpire is also responsible for allocating money in the Acquisition Phase and supplying intelligence information. In the Operations Phase, the Umpire makes decisions based on Red or Green requests and upon how the game is proceeding.

This section of the manual will discuss in detail the various decisions for which the Umpire is responsible.

3.1.1 Logging In and Running COMEL

Any terminal connected to the VAX/VMS system can be used to run COMEL. Just turn the terminal on and press the return key. If everything is in working order, the computer should display the word, USERNAME: . In response to USERNAME: , enter the LOGIN name provided (eg, COMEL) and press return. The computer will display PASSWORD. Enter the PASSWORD provided then press the RETURN key. If the message "User authorization failure" is displayed, check to see that you have the correct username and password, press the return and try again.

After a successful LOGIN, the computer will prompt for USER input with a "$ ".

To run COMEL, input the following item (without quotation marks):

"@COMEL"

Then press the RETURN key (hereafter, <RET >), and COMEL GAME OPTION MENU will be displayed.

3.2 UMPIRE OPTIONS

The following MENU displays the initial actions that are available to the Umpire at the start of each game, during certain stages of the play of the game, and at the conclusion of play of each game. The Red and Green Players

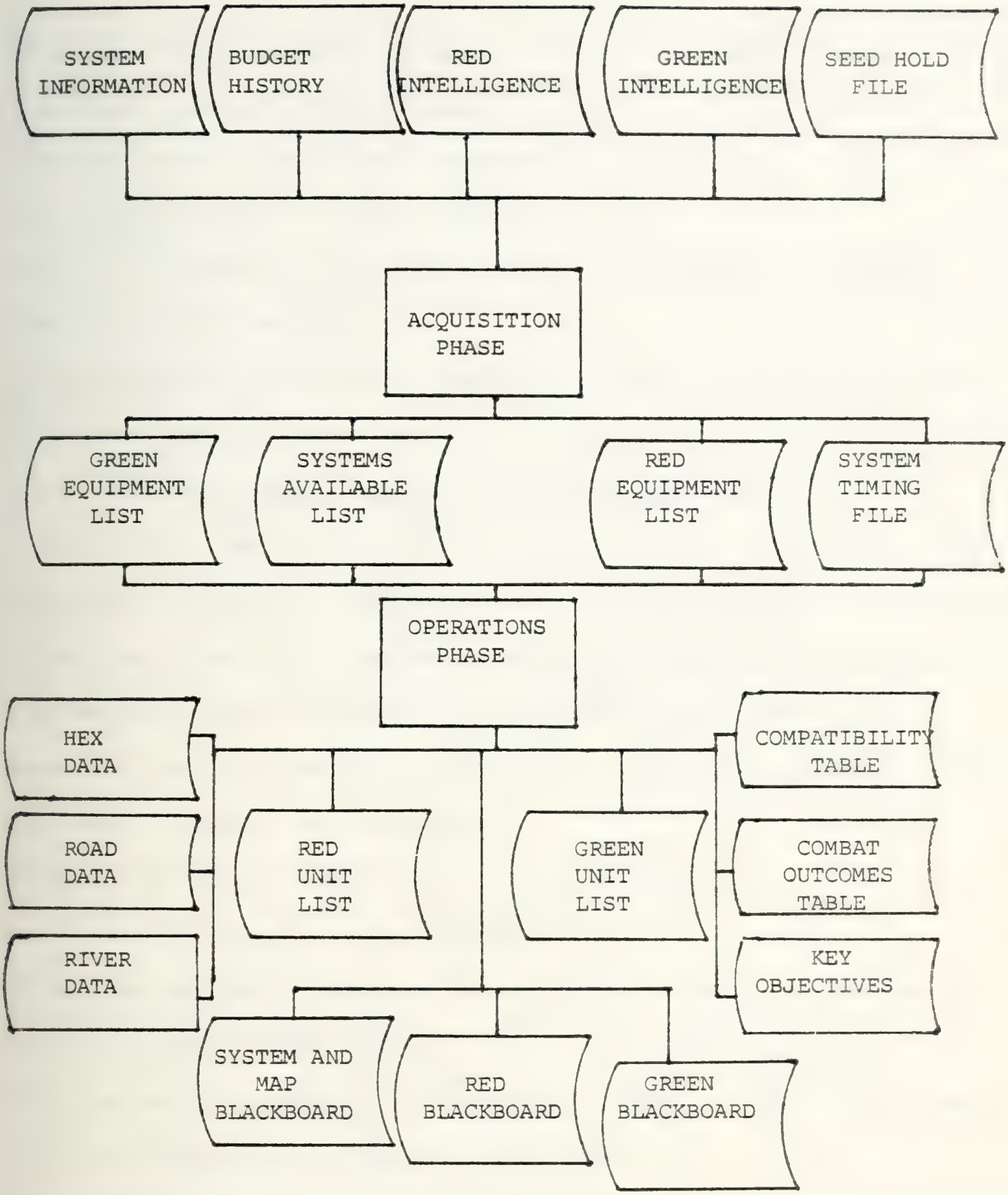
should not be signed on at this time (or at least not past the COMEL ACQUISITION game header display described in Section 4).

```
COMEL WAR GAME OPTIONS
-----------------------
! CHOOSE: ##          !
-----------------------
##  ACTION REQUIRED
--  ---------------------------------------------------
 1  NEW GAME : DEFAULT  DATA/EQUIPMENT FILE EMPTY
 2  NEW GAME : DEFAULT  DATA/OPERATIONS  START
 3  NEW GAME : DEFAULT  DATA/ACQUISITION START
 4  OLD GAME : CONTINUE DATA/DESIGNATED SAVE AREA
 5  MOD GAME : TAILOR   DATA FILES
 6  SAVE   GAME
 7  DELETE GAME
 8  DELETE FILE
 R  START  GAME
 E  EXIT   COMEL
```

Enter one of COMEL options in this menu. Described next are the effects of each option. The purpose of this menu selection is to run COMEL, or to save, delete or modify the files used by the game. See the attached Figure (A-11) for the architecture of the files.

3.2.1 <u>New Game: Default Data/Equipment File Empty</u>

All COMEL system files are loaded with the data necessary to run the game. The equipment list files are empty, which means the players start the Acquisition Phase with no existing equipment. The players acquire all the electronic equipment they need to operate the forces in the projected scenario. All electronic equipment will have to be procured and placed in service through the acquisition process.



COMEL FILE ARCHETECTURE

FIGURE A-11

When option 1 is selected and while the appropriate files are being loaded, the message

SETTING UP NEW GAME: WAIT PLEASE

will be displayed at the terminal.

After successfully setting up the game files, the message

GAME FILES ARE READY [C/R]

is displayed. Respond by pressing <RET>. The main menu will then appear and COMEL can be run.

3.2.2 New Game: Default Data/Operations

All COMEL system files are loaded with the data necessary to run the game starting at the Operations Phase. A sufficent set of electronic equipment has been provided to the Red and Green Players for adequate communications.

When option 2 is selected and while the appropriate files are being loaded, the message

SETTING UP NEW GAME: EXTENSIVE, WAIT PLEASE

will be displayed at the terminal.

After successfully setting up the game files, the message

GAME FILES ARE READY [C/R]

is displayed. Respond by pressing <RET>. The main menu will then appear and COMEL can be run.

3.2.3 New Game: Default Data/Acquisition Start

The COMEL files are loaded with a standard set of data for games that intend to exercise the Acquisition Phase and the Operations Phase. The Acquisition Phase is not

started with a "clean slate" of equipment. Realistically, we never start procuring for future defense needs without "current defense capability". There is always a curent defense capability. However, as new threats are perceived and new technologies emerge, acquisition plans are developed and executed to modernize forces to meet these threats. In this case, the Red and Green equipment files will contain a set of hypothetical default equipment that satisfies the current threat scenarios. Various acquisition strategies can be explored using this common starting point so that a successful stategy can be found that will meet the potential threat (and eventual war).

As before, the message

SETTING UP NEW GAME: MINIMAL, WAIT PLEASE

will be displayed at the terminal.

After successfully setting up the game files, the message

SETUP FINISHED [C/R]

is displayed. Respond by pressing <RET>. The main menu will then appear and COMEL can be run.

3.2.4 Old Game: Continue Data/Designated Save Area

Selecting this option will cause the following menu to be displayed:

```
----------------------
| OLD GAME SELECTION |
| CHOOSE:  ##        |
----------------------
   ##  ENTER SAVED WAR GAME
   --  --------------------
    0  EXIT SAVED GAMES
    1  COMEL WAR GAME 1
    2  COMEL WAR GAME 2
    3  COMEL WAR GAME 3
    4  COMEL WAR GAME 4
    5  COMEL WAR GAME 5
    6  COMEL WAR GAME 6
    7  COMEL WAR GAME 7
    8  COMEL WAR GAME 8
    9  COMEL WAR GAME 9
```

This option assumes that a war game played earlier has been saved to one of these nine areas. Selecting a -0- will force an exit back to the main menu without affecting any COMEL files. Should a 1 through a 9 be selected, all files for that war game will be restored to the same state they were in when saved previously with the SAVE GAME option. After restoration, the main menu will appear and COMEL can be run. A wait message will appear while files for the appropriate game are being loaded.

3.2.5 Mod Game: Tailor Data Files

Selection of option -5- assumes a knowledge of the operation, program and data flow of COMEL. With this option, the war game can be tailored to specification at the FILE level. That is, a war game can be set up with a different system data file than standard, or with a Red equipment file from one game and a Green equipment file from another game. The same electronic equipment used in one scenario can be used in a different scenario to see what

changes will result in the game (ie, change the MAP for the Operations Phase). There are an unlimited number of combinations that can be made by using this option to tailor files. The Thesis and Maintenance Manual should be read and understood prior to setting up tailored files.

There will be a series of self explanatory questions dealing with files to be used. Answer each question 'yes' or 'no'. If yes, a file name will be requested.
If no, the default for that file will be used. After files are set up,
END OF TAILORED FILES,[C/R]
is displayed. Respond by pressing <RET>. The main menu will then appear and COMEL can be run.

3.2.6 Save Game

The selection of -6- will result in the following menu:

```
----------------------
| SAVE GAME TO FILE  |
| CHOOSE:  ##        |
----------------------
   ##  ENTER GAME AREA FOR SAVE
   --  ------------------------
    0  EXIT  GAME SAVE ROUTINE
    1  COMEL WAR GAME 1
    2  COMEL WAR GAME 2
    3  COMEL WAR GAME 3
    4  COMEL WAR GAME 4
    5  COMEL WAR GAME 5
    6  COMEL WAR GAME 6
    7  COMEL WAR GAME 7
    8  COMEL WAR GAME 8
    9  COMEL WAR GAME 9
```

Using this option, all game files used in COMEL will be saved to one of these nine areas. Option -0- will cause a

return to the main menu without affecting any COMEL files. A -1- through -9- will save the COMEL files prefixed with the SAVE GAME number selected. The main menu will then appear for further action. When a save file is selected, new versions of all files in that area are created so that information in old files is not lost.

3.2.7 Delete Game

A directory listing of all files for war game -1- through war game -9- will be displayed at the terminal. After the directory listing the display

GAME TO BE DELETED?[1-9]

is given. Enter a <RET> to go back to the main menu or enter the war game to be deleted. Then the following will be displayed:

VERSION # [IE NUMBER AFTER ;]

Input the specific version number to delete the game (1,2,3 etc). A <ret> with no number will result in the main menu. Assuming a correct version is entered, displayed next is:

END OF DELETE?[Y/N]

If 'n' is entered, another game can be deleted without first returning to the main menu. 'y' returns directly to the main menu.

3.2.8 Delete File

A directory listing of war game files is displayed. Any file displayed on the terminal can be deleted by correctly specifying its game, version # and file name.

After the directory listing,

GAME TO BE DELETED?[1-9]

is displayed. A file under that war game will be deleted, not the entire game. If a <RET> is entered, control will be passed to the main menu.

VERSION # [IE, NUMBER AFTER ;]

Input the version number of the file to delete (1,2,3, etc). A <RET> will result in control passing to the main menu. Assuming a version # is entered,

FILE?(REQUIP,RINTEL, ETC)

Enter the file that is to be deleted. If a <RET> is entered, control will be passed to the main menu. If a correct Game, Version and File name are entered, the next display will be

END OF DELETE?[Y/N]

Another game can be deleted if "yes" is entered.

3.3 START GAME

The administrative initialization of the game is now complete and, with option -R-, the actual COMEL war game (UMPIRE.FOR) now begins. IF a CONTROL Y (a panic exit) is entered in any module under UMPIRE control, the game will be stopped, and control will pass to the initial menu (Section 3.2). Variables in arrays will not be saved, but all files will be at the same state they were in prior to the CONTROL Y (ie, only the current turn information will be lost). The

files can be saved or the game started again from the previous turn.

The -R- option will display the following menu:

```
*----------------------------------*
*     COMEL WAR GAME OPTIONS       *
*     CHOOSE:  ##                  *
*----------------------------------*
   ##  ACTION REQUESTED
   --  ----------------------------
    1  GAME INFORMATION
    2  RUN  ACQUISITION ONLY
    3  RUN  OPERATIONS PHASE ONLY
    4  RUN  COMPLETE GAME
    E  EXIT COMEL
##
```

Option -1- results in game information. Option -2-,-3- or -4- start the game in the phase or phases selected. Since each phase of COMEL can require hours to play, these options give the Umpire time management control of COMEL. Also, COMEL can be played by groups interested in Acquisition only, or Operations only.

3.3.1 Execution Options

The Acquisition Phase can be stopped at any time in order to enter the Operations Phase. If the Operations Phase is stopped, and the Acquisition Phase re-entered, no problems will occur unless the Operations Phase is re-entered. In this case, the Operations Phase will have to be started again at turn one in order to account for the new data entered through Acquisition. COMEL can be exited by entering an -E-.

3.3.2 Game Information

Game information may be selected for an overview of COMEL and the Umpire's role in the play of the game. Displayed first is:

```
---------------------- GAME INFORMATION --------------------
```

Up to 15 lines will be displayed at a time. Next is displayed:

```
PAGE ##: ENTER 0 TO EXIT
[RANGE; 0 TO 100]
```

Enter the page number to be displayed or -0- to exit this routine. When -0- is entered,

```
--------------------------------------------------------------
[C/R]
```

is displayed. Now enter a <RET> to return to the menu.

3.4 ACQUISITION PHASE CONTROL

The Umpire is an active participant in COMEL and will have to make many decisions that can effect the outcome of the game. A plan, or strategy, should be selected prior to playing the game to establish some mutually acceptable agreement as to the extent the Umpire can vary parameters which influence the outcome of the game. The actual effects of the players' decisions will not be known until the Acquisition Phase is ended and the war started. Even then, the ultimate winner can vary depending on the players' tactics in the Operations Phase. It is important for the Umpire to be consistent in use of Umpire controls to prevent one side from gaining an unearned advantage.

The first display that the Umpire will see is as follows:

```
***********************************************************
*  CCCC   000   M    M EEEEE L                            *
* C      O   O MM MM E     L                              *
* C      O   O M M M EEEE  L                              *
*  CCCC   000   M    M EEEEE LLLLL                        *
*                                                         *
*   A    CCCC  QQQ  U   U I SSSSS I TTTTT I  000  N   N *
*  A A  C     Q   Q U   U I S     I   T   I O   O NN  N *
* AAAAA C     Q   Q U   U I  SSS  I   T   I O   O N N N *
* A   A  CCCC  QQQQ  UUU  I SSSSS I   T   I  000  N   N *
*                  Q                                      *
* SSSSS TTTTT   A    GGGG EEEEE                           *
* S       T    A A  G     E                               *
*  SSS    T   AAAAA G GGG EEEE                            *
* SSSSS   T   A   A  GGGG EEEEE                           *
***********************************************************
```

PLEASE ENTER A 4-7 DIGIT ODD NUMBER TO BE USED AS A SEED
FOR THE RANDOM NUMBER GENERATOR USED TO DETERMINE
THE START OF WAR:

A seed number is requested for use in determining the start of the war. War can occur at any time from year two on. The probability of war increases from '0.1' at the end of year 2, to a maximum of '0.9' at the end of year 9.

Each turn of the acquisition process can vary in time according to the Umpire's perception of how fast action should take place. The turns in the Acquisition Phase represent a year in the budget process. The Umpire will see the display,

ENTER LENGTH [MIN] OF TURN, OR, -0- TO STOP

The following can be used as a guide for the turn lengths:

10 MINUTES - program will not allow for a turn of less than 10 minutes.
90 MINUTES - initial acquisition year
60 MINUTES - 2nd year
30 MINUTES - each additional year

If both sides finish before time is up, the next turn will begin immediately.

3.4.1 Budget

Prior to each game year of the Acquisition Phase, the Umpire is prompted for the amount of money the Red and Green teams can spend during the coming year. This money is expressec in terms of a ficticious denomination called "MEGABUCKS (M)". A normal amount that will be spent per system per year is between 10-15M. Information requests made by Red or Green range from 10-20M per request. Once a system is started in the acquisition process, money will be obligated for that system throughout its life cycle. Money will not be obligated from the players budget if a particular development cycle is finished and that system has not been started in another cycle. The amount of money the Umpire gives each player will depend on the size of operation intended. The majority of costs in the game will be in the early years of acquisition as equipment is cycled through Research and Development (R+D) and Manufacturing for Deployment (M+D). Once they are in Operation and Maintenance (O+M), the budgetary needs stabilize at around 5-15M per system. The Umpire should also rememoer that an

additional amount of money should be allocated for possible Intelligence requests.

To help with the requests, the Umpire is provided a budget history. This history is presented from year 2 on. It includes the previous years budgets given Red and Green along with the amount of that Budget the players spent. It also includes any budget requests made by the players. The Umpire will see

BUDGET HISTORY IS AS FOLLOWS

YEAR	RED BUDGET	GREEN BUDGET	RED BGT USED	GREEN USED	RED BGT REQUEST	GREEN REQUEST
1	500.00	500.00	214.00	214.00	0.00	600.00
2	600.00	600.00	79.00	75.00	0.00	800.00

No budget history means that it is game turn one. The Acquisition Phase is tied to the budget since all depends on when an item starts R+D, M+D or O+M.

Next the Umpire will see

PLEASE ENTER RED TEAMS BUDGET FOR YEAR 3
=

then

PLEASE ENTER GREEN TEAM BUDGET FOR YEAR 3
=

After the budgets are entered, that year's budget update is complete and the program will continue to the synchronization and control stage.

Recommended budgets for the default game shown in Figure A-12:

ACQUISITION YEAR	RECOMMENDED BUDGET
1	480M
2	490M
3	520M
4	520M
5	490M
6	480M
7	460M
8	450M
9	450M

RECOMMENDED BUDGETS

Figure A-12

3.4.2 Synchronization and Control

After the Umpire enters the length of the current year and gives Red and Green Players a budget for the year, the following message will appear

WAITING FOR GREEN & RED...17:30:10

The Umpire's program will remain here until Red and Green log on and continue past the header, at which time the following message will appear

TIME...17:31:20

This display will repeat every 10 seconds on the Umpire's terminal until the time alloted for that year has expired, or, until both players have completed that year turn. At that time the Umpire will see

```
END YEAR  3   at...17:45:50
[C/R]
```

Enter the <RET> for the intelligence update routine.

3.4.3 Intelligence Update

The Umpire automatically enters the intelligence update module at the end of each game year. The Umpire's responsibility is to check for Red and Green Intelligence requests. The answers to the requests can be found by checking the game summary for each player. The Umpire also checks for other requests contained in the mail files. The Umpire uses the update mode to enter, in free form, an answer to the player's requests.

The following menu is displayed to the Umpire during the intelligence update

```
*---------------------------*
* INTELLIGENCE UPDATE MENU  *
* CHOOSE ##                 *
*---------------------------*
   ##  ACTION REQUESTED
   --  ---------------------
    1  RED   GAME SUMMARY
    2  GREEN GAME SUMMARY
    3  READ  RED   MAIL
    4  READ  GREEN MAIL
    5  RED   INTEL REQUEST
    6  GREEN INTEL REQUEST
    7  UPDATE RED INTEL
    8  UPDATE GREEN INTEL
    E  EXIT INTEL
?
```

The Umpire enters option 1 thru 8 or E. No intelligence will be provided Red and Green unless the Umpire enters option 7 or 8. The Umpire will be given a second chance to enter the update after the option to exit is entered.

3.4.3.1 Red Game Summary or Green Game Summary: Option 1 or 2 enables the Umpire to review the status of the Red or Green Player.

```
     SYSTEM STATUS...16:08:54
     ------------------------
     (YEAR  4)

   *DECISION TIME:  59 MIN*
   |----------------------------|
   | CHOOSE: FROM ##            |
   |----------------------------|
     ##   TITLE
     --   ------------------------
     1    SYSTEMS SUMMARY
     2    SYSTEMS DEPLOYED
     3    SYSTEMS IN R & D
     4    SYSTEMS FINISHED R&D
     5    SYSTEMS M & D
     6    SYSTEMS TO BUY
     E    EXIT SYSTEMS STATUS
?
```

Explanation of the various options will also be included in a subsequent section of the Users Manual.

3.4.3.2 Read Red Mail or Read Green Mail: Options 3 and 4 display the free form input from the Red or Green Player to the Umpire. Typically the mail will contain questions or comments of a general nature. The player has not spent any money to enter these questions and so substantial information should not be supplied.

3.4.3.3 Red Intel Request or Green Intel Request: Options -5- and -6- enable the Umpire to look at specific intelligence requests made by the Red and Green Players. These requests were paid for during the year that the player just finished. If the Umpire does not check the request, the players money will have spent for nothing. (The Umpire

may choose to give no information; ie, Murphy's Law). It is recommended that specific questions be answered with a yes, no or maybe and that general questions be given a more vague answer.

A general intelligence request means that the player is asking for some general idea of what the other player is doing. Be sure to include the system name with the answer. (Yes, artac 1 IS in R+D.) Information to answer the questions may be obtained from options -1- and -2-, Systems Status. An example follows:

```
****************************
* RED INTELLIGENCE REQUEST *
****************************
A general Intel brief is requested.
IS artac 1 in R&D?
********************************************
[C/R]
```

3.4.3.4 Update Red Intel or Update Green Intel: On selection of option -7- or option -8-, the Umpire will see:

```
ENTER RED UPDATE

****************************************

****************************************

END UPDATE
[C/R]
```

After the initial set of asterisks, the Umpire enters an answer to Red or Green's intelligence request. The Umpire can enter a response to a players mail request from this menu selection as well. Enter a <RET> when finished to return to the Intelligence Menu.

3.4.3.5 Exit Intel: The Umpire should be certain that all intelligence requests are satisfied prior to exiting the Intelligence Menu. Once the Intelligence Menu is exited, the next game turn will begin. A confirmation will be required in order to exit.

3.4.4 End of Current Turn

After the Umpire exits the Intelligence Menu, the message

```
END YEAR                4 AT...16:08:35
[C/R]
```

will be displayed. The Umpire is expected to enter a <RET>. One of two events will then happen. Either war occurs, or the next budget year begins. War will occur depending on the turn and the random number returned. The later the year, the more probable it is that war will occur. For example, on either event, the Umpire will see

```
IF 0.200 IS LARGER THAN 0.199 THEN WAR BEGINS.
[C/R]
```

If war occurs, the Umpire will see

```
!!!!!!!!!!!!!!! WAR !!!!!!!!!!!!!!!

DO YOU REALLY WANT A WAR TO START?[Y/N]
```

The Umpire then decides if war should start now or later. Should the war start, the Acquisition Phase ends.

3.5 OPERATIONS PHASE CONTROL

During the Operations Phase the Umpire must keep abreast of the general situation on the map, since the Umpire will be acting as National Command Authority (NCA). The Umpire will have a chance at the end of the movement module and the end of the combat module to review the unit positions, goals and combat values for both sides to make decisions. At the beginning of the first turn the Umpire must the players when to begin their turn by going beyond the Operations Phase logo. (The terminal will cue the Umpire when to do this.) At the beginning of each turn the Umpire also must decide how long the players' turn will be.

When playing only the Operations Phase, the Umpire must designate whether the Operations Phase is being entered for the first time (in which case equipment allocation will be required) or whether a game already in progress is being resumed after a ceasefire. If the Operations Phase is being entered for the first time, the Umpire will have the option of using the default unit lists or interactively building new lists. If the equipment lists are empty, the Umpire has the option of interactively building new equipment lists.

3.5.1 <u>Rules of Engagement (ROE)</u>

The NCA has to decide how much freedom of action to allow the deployed JTF. The NCA can require personal approval of all attacks, allow the JTF Commander to make those decisions, or relax the rules so that the local

commander can attack targets of opportunity without higher headquarters approval. The Umpire must set the rules of engagement at the beginning of the Operations Phase and can change them at the beginning of each turn. While retaining approval authority, the NCA will receive messages when any unit wishes to attack and can obtain open communications channels through the JTFHQ and up to the NCA. The NCA makes the attack decision and also decides whether to change the rules of engagement at that time.

For example the NCA might want to retain approval authority until the first attack of the game. Once the shooting starts, the NCA might give approval authority to the JTF Commander. A couple of turns later, when the fighting gets heavy, the NCA might give control to local commanders then raise the approval authority back higher as the war nears an end.

Regardless of the rules of engagement, the NCA always retains approval authority for the use of anti-satellite weapons.

3.5.2 End of War

At the end of each turn, unless one side has won a decisive victory, the Umpire must decide whether to end the war and whether to declare a winner. If the Umpire does not want to end the war, a ceasefire can be declared, the files can be saved, and fighting can be resumed at a later time. (See Section 4.6)

4. THE PLAYER'S GAME

4.1 LOGGING IN AND RUNNING COMEL

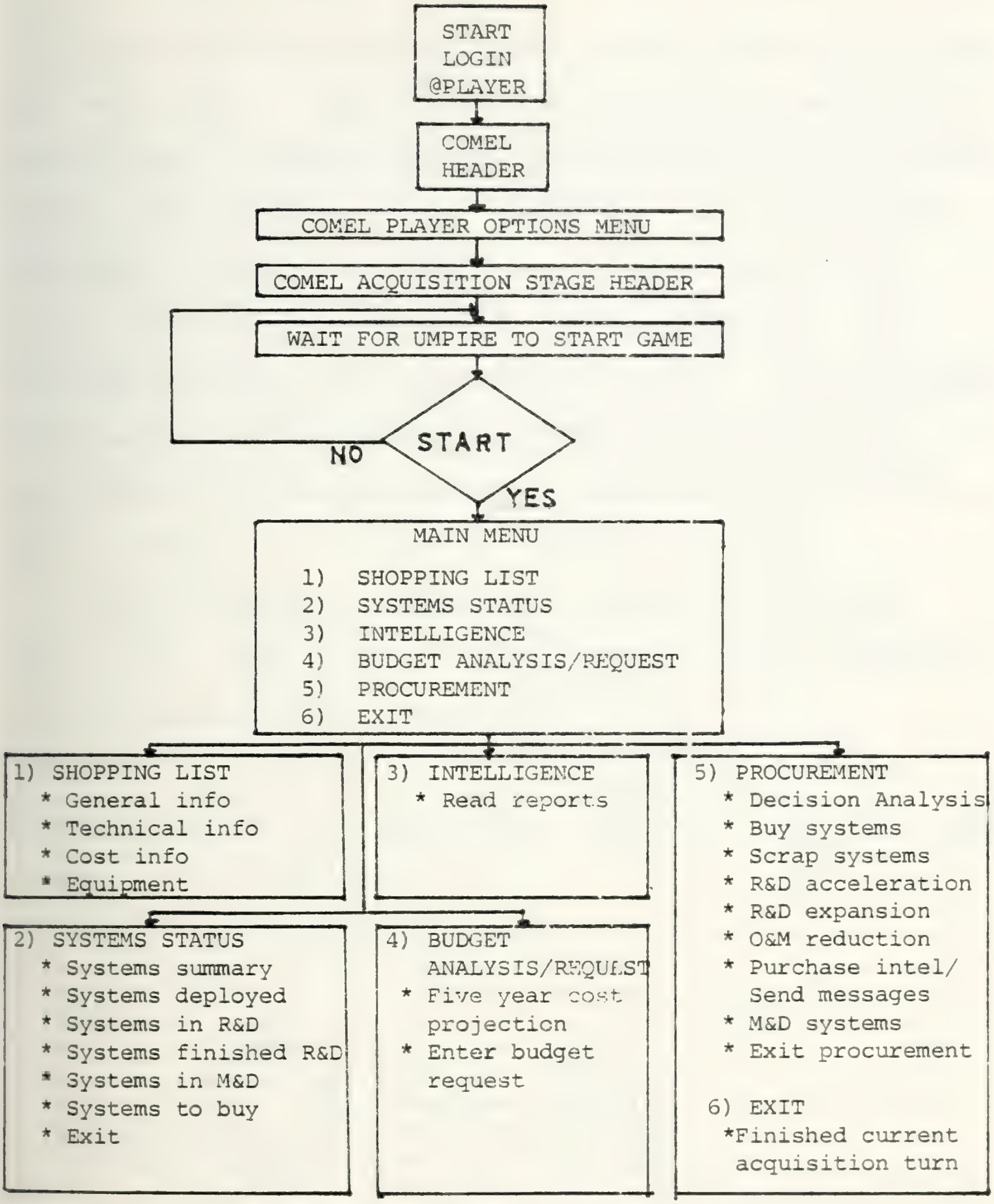
The following subsections describe:

a. The procedure used to LOGIN on the VAX/VMS computer and start the players' game.

b. The steps the player should follow to successfully run any version of COMEL.

The Red and Green Players (or staffs) have many actions to take in order to successfully run COMEL. Preplanning is essential to achieve the maximum benefit from this exercise.

The purpose of the Acquisition Phase of COMEL is to give the players a appreciation of the complexities of joint communications systems acquisition and planning. The Acquisition Phase consists of those steps necessary to design, test, and evaluate the system and to produce and install it. The following sections will enable the user of the systems to tailor forces with that equipment which will meet the anticipated threat. Figure A-13 provides an overview of the player options available during the Acquisition Phase.



PLAYER ACQUISITION OPTIONS

FIGURE A-13

Any terminal connected to the VAX/VMS system can be used to run COMEL. Just turn the terminal on and press the return key. If everything is in working order, the computer should display the word, USERNAME: . In response to USERNAME: , enter the LOGIN name provided (eg, COMEL) and press return.The computer will display PASSWORD. Enter the PASSWORD provided then press the RETURN key. If the message "User authorization failure" is displayed, check to see that you have the correct username and password, press the Return and try again.

After a successful LOGIN, the computer will prompt for USER input with a "$ ". To run COMEL, input the following item (without quotation marks):

"@PLAYER"

Press the RETURN key (hereafter, <RET >), and the COMEL HEADER will be displayed.

```
-------------------------------------------------------
!                                                     !
!   CCCCC                                             !
!  CCCCC       0000                                   !
! CC          000000     M      M                     !
! CC         00    00    MM    MM    EEEEEEE          !
! CC         00    00    MMM MMM     EEEEEE     L     !
!  CCCCC     00    00    MM M MM     EE         LL    !
!   CCCCC     000000     MM    MM    EEEEEE     LL    !
!              0000      MM    MM    EE         LL    !
!                        M      M    EEEEEE     LL    !
!                                    EEEEEEE    LLLLLL !
!                                               LLLLLLL !
!                                                     !
-------------------------------------------------------
YOU CAN ENTER THE CARRIAGE RETURN AT ANY TIME
UMPIRE PERMISSION IS NOT REQUIRED
[C/R]
```

4.2 PLAYER OPTIONS

The first menu displayed to the player is as follows

```
*---------------------------*
*   COMEL PLAYER OPTIONS    *
*   CHOOSE: ##              *
*---------------------------*
  ##  ACTION REQUESTED
  --  ----------------------
   1  GAME INFORMATION
   2  RED   PLAYER?????
   3  GREEN PLAYER?????
   4  ACQUISITION PHASE ONLY
   5  OPERATIONS  PHASE ONLY
   6  BOTH PHASES
   E  EXIT GAME
##
```

The synchronization of players is not necessary until the Acquisition Phase or the Operation Phase is entered. Caution should be taken in the selection of phase to ensure the it coincides with the phase selected by the Umpire (ie, option 4, 5, or 6). The player will have a second chance to confirm the phase selected. Only the options listed in the menu will be accepted.

4.2.1 Game Information

If Game Information is desired, enter option -1- to see

```
--------------------- GAME INFORMATION --------------------
```

Up to 15 lines will be displayed at a time. Next is displayed:

```
PAGE ##: ENTER 0 TO EXIT
[RANGE; 0 TO 100]
```

Enter the page number to be displayed or -0- to exit this routine. When -0- is entered,

----
[C/R]

is displayed. Now enter a <RET> to return to the menu.

4.2.2 Preliminary Requirements

The Red Player must enter option 2 and the Green Player must enter option 3. If both players select option 2 or both select option 3, the synchronization of the game cannot be accomplished. The following is displayed when option 2 or 3 is selected.

YOU ARE THE GREEN PLAYER.

or

YOU ARE THE RED PLAYER.
[C/R]

4.2.3 Phase Selected

Enter option 4, 5 , or 6 as appropriate after indicating Red or Green. These options will initiate the start of the game and will proceed to the player's portion of the Acquisition or Operations Phase as appropriate (see sections 4.3 or 4.5).

4.2.4 End of Game

At the end of the game the main menu will again be displayed. Selecting option -E- will exit the player game.

4.3 COMEL ACQUISITION PHASE

The initial portion of the Acquisiton Phase has been entered when the following logo has been displayed.

```
**********************************************************
*  CCCC  OOO   M   M EEEEE L                             *
* C     O   O MM MM E     L                              *
* C     O   O M M M EEEE  L                              *
*  CCCC  OOO   M   M EEEEE LLLLL                         *
*                                                        *
*   A    CCCC  QQQ  U   U I SSSSS I TTTTT I  OOO  N   N  *
*  A A  C     Q   Q U   U I S     I   T   I O   O NN  N  *
* AAAAA C     Q   Q U   U I  SSS  I   T   I O   O N N N  *
* A   A  CCCC  QQQQ  UUU  I SSSSS I   T   I  OOO  N   N  *
*                  Q                                     *
* SSSSS TTTTT   A    GGGG EEEEE                          *
* S       T    A A  G     E                              *
*  SSS    T   AAAAA G GGG EEEE                           *
* SSSSS   T   A   A  GGGG EEEEE                          *
**********************************************************
DO NOT ENTER THE CARRIAGE RETURN UNTIL
INSTRUCTED TO DO SO BY THE UMPIRE
[C/R]
```

Do not proceed past this point until told to by the Umpire; at which time enter a <RET>. When the <RET> is pressed the following is displayed:

WAITING FOR OTHER PLAYER TO BEGIN AT...14:37:42

The program will remain at this point until the opposing player has also entered a <RET>. This will ensure that the Red and Green Players will have exactly the same amount of time to make decisions during the coming acquisition year.

4.4 MAIN ACQUISITION MENU

The purpose of the Acquisition Phase is to assemble a credible stockpile of electronic equipment to meet an anticipated threat. The goal of the player is to procure those systems that will satisfy the threat forecast.

Always be aware of the budget money remaining and the decision time left. These items are at the top of most displays. When the decision time is -0-, all further entries will result in a move to the main Acquisition Menu so control can be passed to the Umpire.

An example of the main menu of the Acquisition Phase is as follows:

```
        COMEL ACQUISITION STAGE
        ----------------------------
       [YEAR  1 : BUDGET $   500.0M]
       [        OBLIGATED $    0.0M]

       *DECISION TIME:  27 MIN*
      |------------------------|
      |CHOOSE: FROM ##         |
      |------------------------|
        ##  TITLE
        --  ---------------------
        1   SHOPPING LIST
        2   SYSTEMS  STATUS
        3   INTELLIGENCE
        4   BUDGET ANALYSIS/REQ
        5   PROCUREMENT
        E   EXIT ACQUISITION
?
```

The option selected should be entered after the '?'. A brief description of each option and then a detailed description follows.

1. SHOPPING LIST. A list of electronic equipment needs that may be selected for further consideration by the acquisition process.

2. SYSTEMS STATUS. This option provides a brief summary of the current status of each piece of electronic equipment under consideration and/or development.

3. INTELLIGENCE. If intelligence was purchased the previous year, that intelligence may be viewed by selecting this option. Also, intelligence purchased previous years may be reviewed.

4. BUDGET ANALYSIS/REQ. This option will provide a five year forecast on budget requirements. A budget request for next year can be submitted.

5. PROCUREMENT. Enter this stage to buy or change the status of the electronic equipment.

E. EXIT. To exit the Acquisition Phase, use this option when finished with the Acquisition Phase before the decision time has been exceeded.

4.4.1 Shopping List

The following is an abbreviated example of a shopping list of equipment that may be selected as candidates for acquisition.

```
DECISION TIME LEFT IS  27 MINUTES AT 14:38:02
*--------------------------------------*
* ENTER ITEM ## /OR/ [-0-] TO EXIT     *
*--------------------------------------*

## SYSTEM   TYPE   ## SYSTEM   TYPE
-- -------- -----  -- -------- -----
 1 artac 1  tac    11 shf-sat  sat
 2 artac 2  tac    12 shf-gt   gtsat
 3 navtac 1 tac    13 vlf      vlf
 4 navtac 2 tac    14 tritac   sw
 5 aftac 1  tac    15 tritaceh sw
 6 aftac 2  tac    16 sat 1    sat
 7 hftty 1  hf     17 gt-sat 1 gtsat
 8 hftty 2  hf     18 sat 2    sat
 9 wbs 1    los    19 gt-sat 2 gtsat
10 wbs 2    los    20 sat 3    sat
##
```

Selections made from the shopping list will not commit any money from the budget. This is only a candidate list of electronic equipment to buy. Once selected from the shopping list and added to the candidate list, systems will remain on the candidate list every subsequent turn until they are purchased.

Enter the menu number (under ##) of the system under consideration. A list of further information about that system will then be made available. After each menu selection the following type of information will appear:

DO YOU WANT MORE INFORMATION ON artac 1 [Y/N]

If more information is not desired, just enter a 'N' or a <RET>. An answer of 'Y' will display:

```
GENERAL INFORMATION ABOUT: artac 1  EQUIPMENT TYPE: tac
?[Y/N]
```

If answer is 'Y' information on equipment type 'tac' is displayed.

```
*******************************************
*                                         *
*  Service Tactical Communication systems *
*  are designed for internal unit comm in *
*  support of unit operations.  They are  *
*  compatible with other tactical comm    *
*  systems of the same generation         *
*                                         *
*******************************************
```

```
TECHNICAL INFORMATION ABOUT: artac 1
?[Y/N]
```

An answer of 'Y' will show the specific technical information about the system that was selected. The information will look (somewhat) like the following.

```
-------------------------------------------
MOBILITY     :     7 NORMAL RELIABILITY: 0.78
SECURITY     :     1 SKIP   RELIABILITY: 0.00
NORMAL RANGE:      3 NORMAL C3 EFF     : 0.51
SKIP   RANGE:      0 SKIP   C3 EFF     : 0.00
OPERABILITY : 0.88 ECM                 : 0.00
FLEXIBILITY : 0.75 ESM                 :    0
NMB SAT BEAM:      0 EWF               :    0
```

Where the technical data items mean:

MOBILITY - The higher the number, the more mobile the platform (Range 0 to 999).

SECURITY - A whole number between 1 and 5. The higher the number, the more secure the system is and the less vulnerable it is to Electronic Warfare.

SKIP - This prefix implies SKYWAVE communications.

NORMAL - This prefix implies GROUNDWAVE communications.

RANGE - The communication range in hexes.

OPERABILITY - A measure of the ease in which a system can be understood, operated and maintained by those trained to do so (Range 0.0 to 1.0).

FLEXIBILITY - A system's ability to accomodate various traffic fluctuations and procedural changes based on operational crisis (Range 0.0 to 1.0).

NBR SAT BEAMS - The number of sat beams that can be sent. These SAT systems use narrow beams.

RELIABILITY - A system's ability to remain operational and perform according to specifications (Range 0.0 to 1.0).

C3 EFFECTANCY (or EFFECTIVENESS) - A measure of a systems probability to successfully accomplish its communications support mission (Range 0.0 to 1.0).

ECM - Electronic Counter Measures, if in effect reduces the C3E value of the system it jams by the amount shown (Range -1.0 to 0.0).

ESM - Electronic Support Measures, increases the combat value of the friendly forces it supports, but must still be directed against an appropriate enemy system (Range 0 to 50.

EW FACTOR - By subtracting the security factor of the enemys's system from the EW FACTOR the result gives the probability of successful EW operations (Range 0 to 5).

Next, cost and quantity information may be selected.

COST INFORMATION ABOUT: artac 1
?[Y/N]

An answer of 'Y' will result in a list like the following:

```
------------------------------------------------
NUMBER     R&D  R&D  ADVANCED ADVANCED
AVAILABLE COST TIME R&D COST R&D TIME
--------- ---- ---- -------- --------
        4    0    0        0        0


M&D  M&D  NORMAL   REDUCED
COST TIME O&M COST O&M COST
---- ---- -------- --------
  12    1        8        4
```

Next, indicate how many of this system type to consider.

ENTER NUMBER OF artac 1 YOU WISH TO CONSIDER:

The following summary is displayed after successfully entering the number of systems:

```
THERE ARE              0 artac 1  IN FILE.
THERE ARE              4 artac 1  MAXIMUM.
YOU WOULD LIKE TO ADD AN ADDITIONAL            4.
          4 artac 1  ADDED.
 SUCCESS
[C/R]
```

or if not entirely successful

```
INVENTORY WAS LESS THAN NUMBER DESIRED,
YOU WERE GIVEN WHAT WAS AVAILABLE.
[C/R]
```

The shopping procedure may be repeated as many times as necessary in order to start procurement of necessary electronic equipment to meet the threat.

4.4.2 Systems Status

Option -2- from the main menu provides the player and Umpire the opportunity to review the status of electronic equipment on file. The following menu lists the current options.

```
    SYSTEM STATUS...14:51:25
    ------------------------
 BUDGET: $ 500.0M  LEFT TO SPEND: $ 286.0M
    [YEAR  1]

 *DECISION TIME:  13 MIN*
|----------------------------|
| CHOOSE: FROM ##            |
|----------------------------|
   ##  TITLE
   --  ----------------------
   1   SYSTEMS SUMMARY
   2   SYSTEMS DEPLOYED
   3   SYSTEMS IN R & D
   4   SYSTEMS FINISHED R&D
   5   SYSTEMS M & D
   6   SYSTEMS TO BUY
   E   EXIT SYSTEMS STATUS
?
```

Options are entered after the '?' is displayed. Only information is displayed, and no actions are taken.

4.4.2.1 Systems Summary: Option -1- provides the following information in systems on acquisition:

```
***************************************
*          SYSTEM SUMMARY             *
***************************************

FROM A TOTAL OF 15 SYSTEMS UNDER CONSIDERATION,
THERE ARE 10 SYSTEMS UNDER THE FOLLOWING
STAGES OF DEVELOPMENT:

NORMAL      RESEARCH & DEVELOPMENT :            3
ACCELERATED RESEARCH & DEVELOPMENT :            3
FINISHED    RESEARCH & DEVELOPMENT :            0
MANUFACTURING FOR DEPLOYMENT       :            4
WORKING UNDER NORMAL OPERATION     :            0
WORKING UNDER REDUCED EFFECTIVENESS:            0
READY TO BE BOUGHT                 :            0

[C/R]
```

The total number of systems selected from the shopping list are the systems under consideration. The total number of

systems in procurement are listed next. A breakdown of systems in each stage of procurement is then listed.

4.4.2.2 Systems Deployed: Option -2- lists the names of those systems currently deployed and operating in a normal or reduced status. A system in reduced status is half as effective as a system in a normal status.

```
***************************************
*         SYSTEMS DEPLOYED            *
***************************************
artac 1   NORMAL
navtac 1  REDUCED

END OF DEPLOYED SYSTEMS.
[C/R]
```

4.4.2.3 Systems in Research and Development: Option -3- lists the systems in normal or accelerated Research and Development. A system in accelerated R+D can enter Manufacturing for Deployment sooner, and at a higher cost, than a system in normal R+D. The year that the system ends R+D is listed next. At the indicated year, if the system is placed into M+D, it will finish M+D and be ready to be placed into operation in the year listed on the right.

```
***************************************
* SYSTEMS IN RESEARCH & DEVELOPMENT   *
***************************************

sat 3     ACCELERATED END R&D YEAR  4 END M&D YEAR  5
hftty 2   ACCELERATED END R&D YEAR  2 END M&D YEAR  3
hftty 2   ACCELERATED END R&D YEAR  2 END M&D YEAR  3
hftty 2   NORMAL      END R&D YEAR  3 END M&D YEAR  4
hftty 2   NORMAL      END R&D YEAR  3 END M&D YEAR  4
hftty 2   NORMAL      END R&D YEAR  3 END M&D YEAR  4

END OF SYSTEMS IN R & D
[C/R]
```

4.4.2.4 Finished Research and Development: The systems listed by option -4- are finished R+D. If obligated for M+D immediately, they will be ready for operation in the year listed on the right.

```
*************************************
*  FINISHED RESEARCH & DEVELOPMENT  *
*************************************
artac 2    END M&D IN YEAR        4
navtac 2   END M&D IN YEAR        5

END OF SYSTEMS FINISHED R & D
[C/R]
```

4.4.2.5 Manufacturing for Deployment: The systems listed by option -5- are in active M+D and will be ready for operation in the year indicated.

```
*************************************
*    MANUFACTURING FOR DEPLOMENT     *
*************************************

artac 1  END M&D IN YEAR            2
artac 1  END M&D IN YEAR            2
artac 1  END M&D IN YEAR            2
artac 1  END M&D IN YEAR            2

END OF SYSTEMS M & D
[C/R]
```

4.4.2.6 Systems Ready to Be Bought: The systems in option -6- are ready to be procured for normal or reduced operation.

```
*************************************
*    SYSTEMS READY TO BE BOUGHT     *
*************************************
wbs 1
vlf
artac 1
navtac 1

END OF SYSTEMS TO BUY
[C/R]
```

4.4.3 Intelligence

This report is obtained by selecting option -3- from the main menu. It will contain answers to intelligence requests made by the player the previous year. An example of the menu is as follows:

```
      INTELLIGENCE REPORT...14:56:56
      ------------------------------
           [YEAR  2]
       DECISION TIME:  29 MIN
   |--------------------------------------|
   | CHOOSE: FROM YEAR ## [-0-] TO EXIT   |
   |--------------------------------------|
             ##  INTEL REPORT
             --  ------------
              1  YEAR  INTEL
?
```

After the '?', enter the year (if there is one listed) to review. An example of year 1 follows

```
INTELLIGENCE REPORT FOR YEAR           1
---------------------------------------------
YES, SAT 3 HAS BEEN PLACED INTO R&D
IT WILL BE IN NORMAL OPERATION BY YEAR 4
ONLY 1 WILL BE PURCHASED
---------------------------------------------
[C/R]
```

The example is a free form response entered by the Umpire.

4.4.4 Budget Analysis/Requests

Option 4 in the main Acquisition Menu provides a breakdown of the current year's budget along with a five year forecast. Only systems that are in an active stage will be forecast. For example a system in active R+D will be included but a system that is finished R+D in the current year and has not been started in Manufacturing for Deployment will not be included in this projection.

Therefore, this option should be used after current year acquisition has almost been completed in order to get a realistic budget projection.

This projection will help in planning for subsequent years and in submitting a proposed budget for the next year. First, the following info will be displayed:

```
*-----------------------------------------------*
* THE FOLLOWING -5- YEAR PROJECTION IS BASED    *
* ON THE CURRENT YEARS  FORCE STATUS WITH THE   *
* FUTURE YEARS BUDGET COMPUTED ASSUMING A       *
* FROZEN FORCE STRUCTURE (NO ADDITIONS) AND     *
* R&D PROCEEDING NORMALLY, FLOWING INTO M&D     *
* AND THE SYSTEMS BEING BOUGHT AS THEY BECOME   *
* AVAILABLE.                                    *
*                                               *
* THIS LIST SHOULD BE USED AS AN AIDE TO SHOW   *
* WHAT HAS BEEN COMMITTED TO FUTURE YEAR        *
* BUDGETS. IT CAN GIVE AN IDEA WHERE BUDGET     *
* REDUCTIONS OR SCRAPPING CAN OCCUR.            *
*-----------------------------------------------*
```

[C/R]

After entering a <RET> the budget forecast is presented.

	NORMAL R&D		ADVANCED R&D		SYSTEMS IN M&D		REDUCED O&M		NORMAL O&M		TOTALS	
	##	CST	##	CST	##	CST	##	CST	##	CST	##	CST
YEAR 1	3	21	3	60	4	48	0	0	0	0	10	129
YEAR 2	3	21	1	30	2	20	0	0	4	32	10	103
YEAR 3	0	0	1	30	3	30	0	0	6	42	10	102
YEAR 4	0	0	0	0	1	27	0	0	9	57	10	84
YEAR 5	0	0	0	0	0	0	0	0	10	72	10	72

DO YOU WANT TO SUBMIT A BUDGET REQUEST FOR YEAR 2 ?[Y/N]
PLEASE ENTER BUDGET REQUEST:

A budget figure for next year can be entered if desired.

4.4.5 Procurement

Select option -5- from the main menu to start the life cycle (see Figure A-1) of systems or change the status of systems already in procurement or operation. A system initially will be in one of three states. First, COMEL may have been entered with systems already in normal Operations and Maintenance. Second, a system placed in consideration via the shopping list may not require Research and Development. Third, systems may need to be started from the beginning of the life cycle starting with normal or advanced Research and Development.

War can start anytime after year 2. Unless the system is already in normal or reduced Operations and Maintenance, the system can be operational in year 3 only by opting for a system requiring only Manufacturing for Deployment in year 2. It will be beneficial to develop a mixed strategy based on when war is most likely to begin.

4.4.6 CONPLAN Decision Review (Procurement)

The player has the following options to facilitate reaching decisions during the procurement of systems.

```
 CONPLAN DECISION REVIEW
 -----------------------
[YEAR  1 : BUDGET $  500.0M]
[MONEY LEFT TO SPEND: $ 500.0M]

*DECISION TIME:  22 MIN*
 |-----------------------------|
 |CHOOSE: FROM ##              |
 |-----------------------------|
   ##  TITLE
   --  ------------------------
    1  DECISION ANALYSIS
    2  BUY SYSTEMS
    3  SCRAP SYSTEMS
    4  R & D ACCELERATION
    5  R & D EXPANSION
    6  O & M REDUCTION
    7  PURCHASE INTELLIGENCE
    8  MANUFACTURE & DEPLOY
    E  EXIT CONPLAN MENU
?
```

Player input is expected after the '?'. A brief description of options will be presented followed by a detailed discussion of each.

1. DECISION ANALYSIS. Shows the player the electronic equipment purchased in terms of aggregate technical performance.

2. BUY SYSTEMS. Allows purchase of electronic equipment that have finished the Manufacturing for Deployment stage.

3. SCRAP SYSTEMS. Scraps electronic equipment to save money.

4. R and D ACCELERATION. Initiates accelerated R+D for electronic equipment requiring R+D efforts.

5. R and D EXPANSION. Allows normal R+D on electronic equipment identified on the shopping list requiring R+D.

6. O and M REDUCTION. Saves money by reducing the operating funds of electronic equipment currently in Normal Operation.

7. PURCHASE INTELLIGENCE. Allows the player to purchase Intelligence information available the next year. Also, the player can send messages to the controller.

8. MANUFACTURE AND DEPLOY. Places electronic equipment finished R+D into the final phase of the life cycle process before purchasing and fielding.

4.4.6.1 Decision Analysis: Option 1 will help analyze current and future capabilities. Options may be selected from:

```
     DECISION ANALYSIS
 ------------------------
[YEAR:  2 TIME LEFT:  27]
 |--------------------------|
 | CHOOSE: FROM ##          |
 |--------------------------|
   ##  TITLE
   --  ----------------------
    1  FORCE CAPABILITY INDEX
    2  FORCE ASSESSMENT
    3  CHANGE DEFAULT WEIGHTS
    4  CHANGE DEFAULT PARAMS
    E  EXIT
?
```

A brief description of the options will be presented followed by an example and discussion of each.

1. Force Capability Index - Graphical summary showing the technical parameters of electronic equipment under development and in operation.

2. Force Assessment - Graphical depiction showing a force assessment based on the total technical parameters and importance weights assigned to each parameter.

3. Change Default Weights - Player can change the importance of each technical parameter by adding or reducing the weights applied. Weights are applied against the Force Assessment depiction (option 2).

4. Change Default Params - Scaling values used on technical parameters can be varied (ie, each parameter is divided by a scaling value).

4.4.6.1.1 Force Capability Index: Option 1 provides a projection of total capability for the current years and up to three additional years. An example of the display follows.

```
                    FORCE CAPABILITY INDEX
    ¦----------------------------------------------------¦
25 -¦                                                    ¦-25
    ¦                                                    ¦
20 -¦                                                    ¦-20
    ¦                                                    ¦
15 -¦                                                    ¦-15
    ¦                                                    ¦
10 -¦                                                    ¦-10
    ¦                                              X     ¦
 5 -¦                     X   X             X   X  X     ¦- 5
    ¦       X             X X X          X  X X X  X     ¦
    ¦----------------------------------------------------¦
          YEAR  3                 YEAR  4           YEAR  5
    ***************** ***************** *****************
    *M CC S CC B EEE* *M CC S CC B EEE* *M CC S CC B EEE*
    *O RR E 33 E WCS* *O RR E 33 E WCS* *O RR E 33 E WCS*
    *B NN C EE A FMM* *B NN C EE A FMM* *B NN C EE A FMM*
    *  GG    S M    * *  GG    S M    * *  GG    S M    *
    *   S      S    * *   S      S    * *   S      S    *
    ***************** ***************** *****************
[C/R]
```

The Y-AXIS values are to be used as a guide for comparison between the current year and projected years. These are scaled values. They will change if the associated scaling parameters are changed (option -4-). Each 'X' marks the level the equipment has reached for that year. The values can be read as a histogram. The technical parameters described immediately below the 'X' are mobility (MOB), range(CRNG and CRNGS for HF in skywave mode), security(SEC), C3 effectiveness(C3E and C3ES), number of satellite beams(BEAMS), EW factor(EWF), ECM effectiveness(ECM), and ESM effectiveness(ESM).

4.4.6.1.2 Force Capability Assessment: Option -2- provides a projection of force capability for the current year and up to three additional years based on summing the totals of each technical parameter times a weighting factor

on the importance of that technical parameter. Initially the weighting factors are equal. An example of the display follows.

```
                   FORCE CAPABILITY ASSESSMENT

   ¦---------------------------------------------------------¦
35-¦                                                         ¦-35
   ¦                                                         ¦
30-¦                                                         ¦-30
   ¦                                                         ¦
25-¦                                                         ¦-25
   ¦                                                         ¦
20-¦                                                         ¦-20
   ¦                                                         ¦
15-¦                                                         ¦-15
   ¦                                              XXXXXXXXXX¦
10-¦                                              XXXXXXXXXX¦-10
   ¦                                   XXXXXXXXXX XXXXXXXXXX¦
 5-¦                        XXXXXXXXXX XXXXXXXXXX XXXXXXXXXX¦- 5
   ¦             XXXXXXXXXX XXXXXXXXXX XXXXXXXXXX XXXXXXXXXX¦
   ¦---------------------------------------------------------¦
   ¦ YEAR  2 ¦  YEAR  3 ¦  YEAR  4 ¦  YEAR  5 ¦  YEAR  6 ¦
[C/R]
```

The value in the Y-AXIS denotes a scaled number to be used for comparison between years displayed on the graph. This graph is presented in a histogram format. Projections are based on all equipment procured entering the subsequent stage and finally being deployed.

4.4.6.1.2 Changing Default Weights: Default weights used in computing force assessment can be changed. Computation of force assessment involves taking scaled value (technical parameter / scaling value assigned) multiplied by this weight and summing them by year. In effect, a sensitivity analysis can be made by changing the weights applied to any technical parameter (initially equally weighted). The following shows the current default weights

and permits each weight to be changed, The current weights are displayed first:

```
THESE ARE THE WEIGHTS APPLIED TO EQUATIONS
TOTAL WEIGHTS MUST SUM TO 1
THE SYSTEM WILL CHECK TOTALS AS THEY ARE
ENTERED.
ENTER CHANGES AS DESIRED:
-------------------------------------------------------------
WTMOB WTCR  WTCRS WTSEC WTC3  WTC3S WTBM  WTEWF WTECM WTESM
----- ----- ----- ----- ----- ----- ----- ----- ----- -----
 0.10  0.10  0.10  0.10  0.10  0.10  0.10  0.10  0.10  0.10
```

An example of a session to change the weights follows:

```
-------------------------------------------------------
MOBILITY WEIGHT:
0.05
COMM RANGE WEIGHT: RANGE [-0- TO -  0.9500000    -]
0.15
SKIP COMM  WEIGHT: RANGE [-0- TO -  0.8000000    -]
0.05
SECURITY   WEIGHT: RANGE [-0- TO -  0.7500000    -]
0.15
C3 EFF     WEIGHT: RANGE [-0- TO -  0.6000000    -]
0.15
SKIP C3    WEIGHT: RANGE [-0- TO -  0.4500000    -]
0.05
SAT BEAMS  WEIGHT: RANGE [-0- TO -  0.4000000    -]
0.15
EWF FACTOR WEIGHT: RANGE [-0- TO -  0.2500000    -]
0.1
ECM FACTOR WEIGHT: RANGE [-0- TO -  0.1500000    -]
0.1
```

The ESM weight is the remainder left from 1. The changed weights are then displayed.

```
-------------------------------------------------------------
WTMOB WTCR  WTCRS WTSEC WTC3  WTC3S WTBM  WTEWF WTECM WTESM
 0.05  0.15  0.05  0.15  0.15  0.05  0.15  0.10  0.10  0.05
-------------------------------------------------------------
```

4.4.6.1.4 Changing Default Parameters: Scaling values used in the force assessment and force index graph can be changed. The following question answer sequence is presented.

```
[C/R]
OLD MOBILITY HIGH:        50
NEW MOBILITY HIGH:
?
25
```

The reduction of this value to 25 doubles the mobility factor displayed in the graphs.

```
OLD COMM RANGE HIGH:       100
NEW COMM RANGE HIGH:
?
200
```

If all the communication gear purchased had excellent comm range, the scale may have to be increased to bring comm range in line with the other factors to consider.

```
OLD COMM SKIP RANGE HIGH:     9999
NEW COMM SKIP RANGE HIGH:
?
5000
```

The skip comm range scale may be reduced in order to increase the importance applied to long range communication.

```
OLD SECURITY FACTOR HIGH:              6
NEW SECURITY FACTOR HIGH:
?
3
```

Intelligence on enemy intentions may show that the security factor should be more of a factor in decisions.

```
OLD C3 EFF HIGH:    1.000000

NEW C3 EFF HIGH:

?

0.5


OLD SKIP C3 EFF HIGH:    1.000000
```

NEW SKIP C3 EFF HIGH:

?

0.75

0.5

The C3 effectiveness figure is shown to be more important and will now be reflected as so in the graphs.

```
OLD NUMBER SAT BEAMS HIGH:    0.5000000
NEW NUMBER SAT BEAMS HIGH:
?
0.25
```

If there are only a small number of an electronic equipment available for purchase, it may be necessary to change a parameter so that the equipment will even show in the graphs.

```
OLD EWF HIGH:             10
NEW EWF HIGH:
?
5

OLD ECM HIGH:              1
NEW ECM HIGH:
?
2

OLD ESM HIGH:              2
NEW ESM HIGH:
?
3
```

Again, the importance of any item can be reduced or increased by changing the scaling value associated with that parameter. Since the technical parameters are scaled by dividing the parameter by its scaling value, an increase of the scaling value will reduce the parameter's importance and

a decrease of the scaling value will increase the importance. The changed scaling values are then displayed.

```
HIGHS
-------------------------------------
MOBILIY              :          25
COMM RANGE           :          50
SKIP COMM RANGE      :        9999
SECURITY FACTOR      :           3
C3 FACTOR            :    1.000000
SKIP C3 FACTOR       :    1.000000
NUMBER SAT BEAMS     :   0.2500000
EWF FACTOR           :           5
ECM FACTOR           :           1
ESM FACTOR           :           1
```

[C/R]

This change will affect the display in options -1- and -2-. After the <RET>, the decision analysis menu is repeated for further action.

4.4.6.1.5 Exit Decision Analysis: On entering option -E-, the player is returned to the procurement menu. If the decision analysis option is selected again, the default parameters will be in effect again.

4.4.6.2 Buy Systems: When electronic equipment has been Manufactured for Deployment, selecting option -2- will present the opportunity to Buy the electronic equipment. A summary of costs for each electronic equipment is displayed along with an option to buy the equipment at normal or reduced cost. An example follows:

```
SYSTEMS READY TO BUY FOLLOWS
[C/R]

SYSTEM       : artac 1
NORMAL  COST:     8
REDUCED COST:     4
MONEY LEFT   :  549.0

BUY?[Y/N]
Y

NORMAL OR REDUCED COST?[N/R]
N
```

If the answer to buying the system is no, it will still be available for purchase anytime the buy routine is entered during the current year. However if a system is available to buy and is not purchased during that year it will not be available later. A system operating under reduced cost is half as effective as a system operating under normal cost. Any system operating under normal cost can always be reduced (and money saved) later. However a system procured at reduced cost cannot be brought back to normal operating effectiveness.

4.4.6.3 Scrapping Systems: Option -3- enables the player to scrap any system entered to date. This can be done to free money for more important systems or for any other reason more money may be needed. The only cost in scrapping a system is the time and money already spent in prior years. The money saved in scrapping is immediately available for use. The following display is generated:

```
DECISION TIME LEFT IS  21 MINUTES AT 15:04:51
BUDGET : $ 600.0M   LEFT TO SPEND : $ 517.0M
*-----------------------------------------------*
* ENTER ITEM ### TO SCRAP /OR/ [-0-] TO EXIT *
*-----------------------------------------------*

### SYSTEM   STAT ### SYSTEM   STAT ### SYSTEM
--- -------- ---- --- -------- ---- --- --------
  1 artac 1  N OP   5 sat 3    AR&D   9 hftty 2
  2 artac 1  N OP   6 hftty 2        10 hftty 2
  3 artac 1  N OP   7 hftty 2        11 hftty 2
  4 artac 1  N OP   8 hftty 2  NR&D  12 ew 4a

###
1
```

All systems in work and their status of procurement are listed. The status is one of the following:

```
N OP - Normal operation and maintenance
R OP - Reduced operation and maintenance
AR+D - Accelerated research and maintenance
NR+D - Normal research and maintenance
FR+D - Finished research and maintenance
MNFD - Manufacturing for deployment
RDY - Ready to be bought
SCRP - System has been scrapped
```

The item number of the system to be scrapped is entered or a zero is entered if scrapping is finished. The system chosen for scrapping is then displayed :

```
SYSTEM TO BE SCRAPPED : artac 1
[C/R]
```

After the return, the status of the system is repeated along with the money to be saved in scrapping the system.

```
IN NORMAL OPERATION
SCRAPPING WILL FREE   : $          8M
```

A confirmation of the scrapping will be required.

```
DO YOU REALLY WANT TO SCRAP IT?[Y/N]
MONEY TO SPEND BEFORE SCRAPPING: $        517M
MONEY TO SPEND AFTER SCRAPPING: $        525M

[C/R]
```

The budget before scrapping and after scrapping is displayed for information purposes.

```
DECISION TIME LEFT IS  20 MINUTES AT 15:05:25
BUDGET : $ 600.0M   LEFT TO SPEND : $ 525.0M
*-----------------------------------------------*
* ENTER ITEM ### TO SCRAP /OR/ [-0-] TO EXIT *
*-----------------------------------------------*

### SYSTEM   STAT ### SYSTEM   STAT ### SYSTEM
--- -------- ---- --- -------- ---- --- --------
  1          SCRP   5 sat 3    AR&D   9 hftty 2
  2 artac 1  N OP   6 hftty 2        10 hftty 2
  3 artac 1  N OP   7 hftty 2        11 hftty 2
  4 artac 1  N OP   8 hftty 2  NR&D  12 ew 4a

###
```

As shown, system 1 is scrapped and more megabucks are available.

4.4.6.4 R and D Acceleration: Accelerated Research and Development is selected to hurry the equipment through R+D and make it available for M+D and Operation sooner. When procurement option 4 for accelerated R+D is selected, the following display is shown:

```
TIME LEFT IS  22 MINUTES AT 14:42:59 :
MONEY LEFT = $ 500.0M
*---------------------------------------------*
* THESE SYSTEMS ARE AVAILABLE FOR ADVANCED *
* RESEARCH AND DEVELOPMENT TO BE READY     *
* IN THE YEAR INDICATED FOR M & D.         *
* ENTER ITEM ## /OR/ [-0-] TO EXIT.        *
*---------------------------------------------*

### SYSTEM   Y/RDY ### SYSTEM   Y/RDY
--- -------- ----- --- -------- -----
  1 sat 3        4   4 hftty 2      2
  2 hftty 2      2   5 hftty 2      2
  3 hftty 2      2   6 hftty 2      2
##
```

There are three data items for each system listed: an item number, the system name, and the year the system would

finish Accelerated R+D. Select those systems to enter accelerated R+D and/or enter a 0 to exit. The cost of accelerated R+D is given next.

```
SYSTEM         :  hftty 2
ADV R & D COST: $          15
BUY?[Y/N]
```

A confirmation is required to expend the money as shown.

```
hftty 2  IS SCHEDULED FOR ADV R&D AND WILL BE READY FOR M&D
         IN YEAR           2

[C/R]
```

The system is repeated along with the year it will be available for M+D. Enter a <RET> and another opportunity to place a system in accelerated R+D will be provided.

4.4.6.5 R and D Expansion: Option -5- is Normal Research and Development. Most of the electronic equipment selected by the shopping list routine will have to undergo Research and Development due to extensive modifications necessary to meet the projected threats. The only difference between normal and accelerated R+D is the money involved and time required for Research and Development. The displays and responses are identical to Section 4.4.6.4.

4.4.6.6 Manufacture and Deploy: When a system is finished R+D, companies have to set up assemblies and tools to manufacture the system and also train people to repair the equipment. This is represented in COMEL by the M+D cost and time delay. Option 6 is the selection to manufacture for deployment. The player can manufacture for deployment any system that appears in this list. However, the system

will not be operational until the system has finished M+D and bought by option -2-. An example display follows:

```
DECISION TIME LEFT IS  18 MINUTES AT 14:46:18
MONEY LEFT = $ 419.0M
*--------------------------------------*
* THE INDIVIDUAL SYSTEMS READY TO      *
* BE MANUFACTURED THEN DEPLOYED:       *
* ENTER ITEM ##  /OR/ [-0-] TO EXIT    *
*--------------------------------------*

### SYSTEM   YR/RDY CST/YR### SYSTEM
--- -------- ------ --------- --------
  1 artac 1       2      12  3 artac 1
  2 artac 1       2      12  4 artac 1
###
```

Enter the item number to manufacture or a zero to exit. On successful addition, the following is displayed:

```
artac 1  IS BEING MANUFACTURED AND WILL BE
         READY FOR DEPLOYMENT IN YEAR
          2
```

If the system could not be added due to lack of funds, an appropriate message would be displayed.

4.4.6.7 Operation and Maintenance Reduction: Option -6- places the specified electronic system in reduced operation and maintenance. The difference in money between normal and reduced operation is saved immediately. This routine is self explanatory and is similar to the scrap routine.

4.4.6.8 Purchase Intelligence: Option -7- enables the player to purchase intelligence information about the opponent. The player can also communicate with the Umpire (without cost). Intelligence is purchased to gain information on systems the enemy is investing in. It might

be possible to enhance your planning significantly with this knowledge. However, do not expect perfect information. The player will only receive information the Umpire decides to give. The following menu is displayed:

```
      INTELLIGENCE REQUEST...14:47:52
      --------------------------------
    BUDGET: $ 500.0M  LEFT TO SPEND: $ 371.0M
       [YEAR  1]
    DECISION TIME:  17 MIN*

   |----------------------------------------|
   | CHOOSE:  FROM ##                       |
   |----------------------------------------|
      ##  TYPE OF REQUEST
      --  ------------------------------
       1  GENERAL INTELLIGENCE BRIEF
       2  SPECIFIC INTELLIGENCE DATA
       3  COMMENT TO CONTROLLER
       E  EXIT INTELLIGENCE REQEST
?
```

General intelligence (option -1-) can be selected once each year. Specific intelligence (option -2-) can be bought for any number of systems if money is available. Each time option -3- is entered, the old controller message is erased.

4.4.6.8.1 General Intelligence: After the '?' enter the option desired. For a general intelligence brief of a non-specific nature enter option -1-. The following is then displayed:

```
GENERAL INTELLIGENCE WILL COST $          15M
AVAILABLE YEAR:             2
DO YOU WANT THIS INTELLIGENCE?[Y/N]
```

A 'Y' answer will commit this year's funds for a response the following year.

4.4.6.8.2 Specific Intelligence: Specific Intelligence can be purchased for systems listed in this menu. It is unlikely that exact information will be provided by the Umpire, but the intelligence received is normally of some value. The more accurately the threat can be estimated the better it can be countered through an appropriate acquisition policy. An example follows:

```
*-------------------------*
* SPECIFIC INTELLIGENCE *
*-------------------------*

PLEASE ENTER SYSTEM:
*************************************
* ENTER ITEM ## /OR/ [-0-] TO EXIT *
*************************************

## SYSTEM   TYPE   ## SYSTEM    TYPE   ## SYSTEM    TYPE
-- -------- -----  -- --------  -----  -- --------  -----
 1 artac 1  tac     7 shf-sat   sat    13 gt-sat 3  gtsat
 2 artac 2  tac     8 shf-gt    gtsat  14 singars   sat
 3 navtac 1 tac     9 vlf       vlf    15 singargt  gtsat
 4 navtac 2 tac    10 tritac    sw     16 abncp 1   abncp
 5 aftac 1  tac    11 tritaceh  sw     17 abncp 2   abncp
 6 aftac 2  tac    12 sat 3     sat    18 awacs     awacs
##
12
```

Enter the item number of the system for which intelligence is desired.

```
R+D INFO FOR SYSTEM sat 3   ?[Y/N] (COST: $20M)
```

Selecting 'Y' will require the Umpire to return a yes or no answer on whether this system is in R+D.

```
INFO ON ENEMY INTENT TO BUY sat 3   ?[Y/N] (COST: $10M)
```

A yes or no answer will be returned on whether the Umpire thinks that the opposing player will proceed beyond R+D.

```
INFO ON NUMBER OF sat 3   ENEMY MAY BUILD?[Y/N] (COST: $10M)
```

An indication on the number of these systems to be built is provided the player.

```
INFO ON DEPLOYMENT DATE OF sat 3   ?[Y/N] (COST: $20M)
```

The date the system will be in an operating status is provided. Once R+D information has been bought on a system, the above corollary questions can be answered at the indicated costs. It might be advantageous to ask for R+D information one year, and the subsequent questions the following years.

4.4.6.8.3 Message: Enter option -3- to ask the controller questions. It may be entered to clear up some questions from earlier intelligence updates.

```
*-------------------------------*
* ENTER MESSAGE TO CONTROLLER *
*-------------------------------*
```

Enter the message. A <RET> on a blank line will exit this session.

4.4.6.8 Exit: Enter an -E- to return to the procurement menu.

4.4.7 End of Acquisition

When the Acquisition Phase is over ("Exit or time run out"), the following information will be provided:

```
END OF YEAR:            2
WAIT...
END YEAR             2 AT...15:07:02
```

Control has now returned to the Umpire. In this example, either turn 3 will start or war will begin.

```
END ACQUISITION...15:07:33
```

4.5 PREPARING FOR THE OPERATIONS PHASE

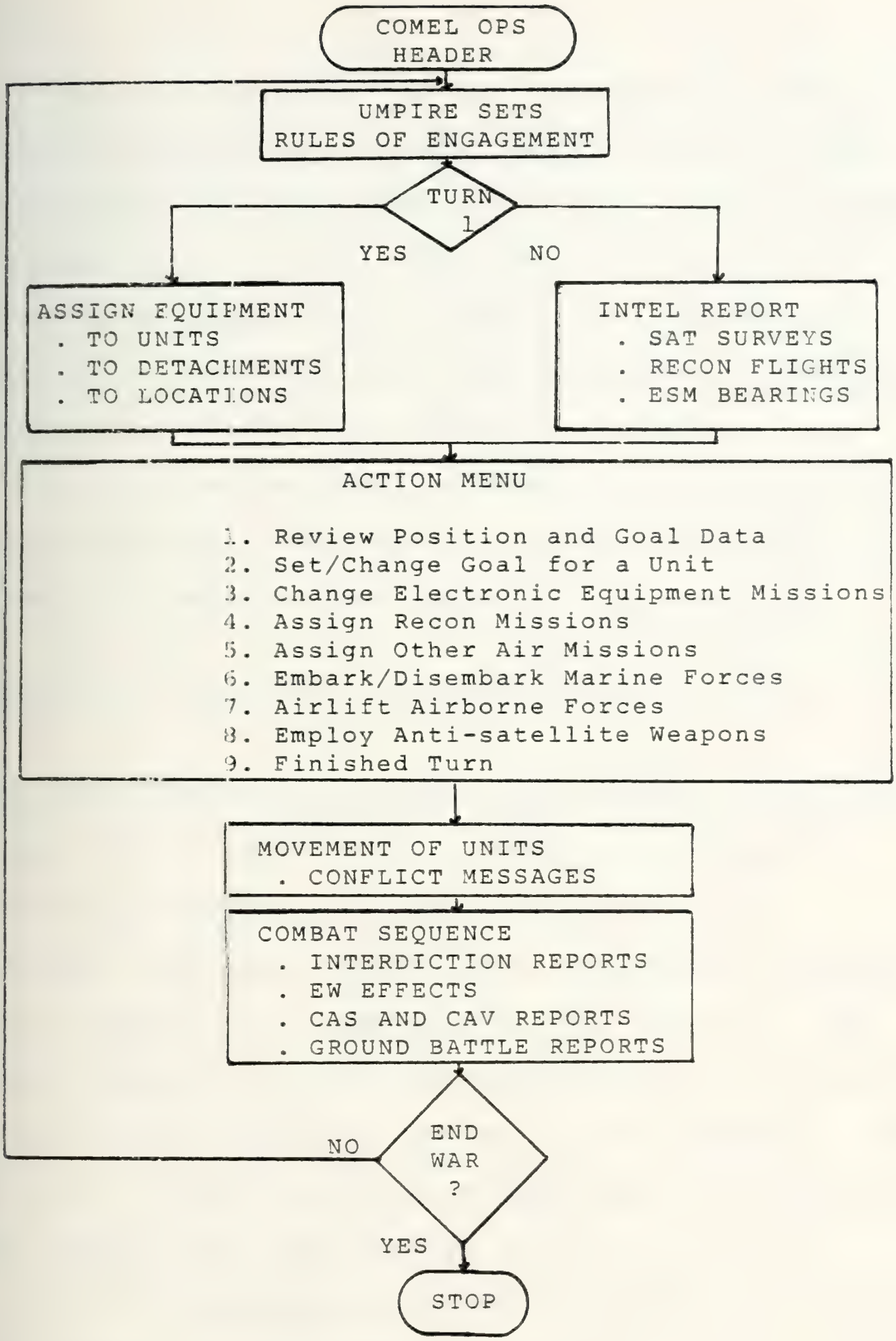
This section of the manual describes the assignment of equipment to units. The steps of an Operations turn are described in the next section. Figure A-14 provides an overview of both sections.

The first step in preparing for the Operations Phase is advanced planning. The players should have available copies of the map, their unit lists, their equipment lists, a general operations plans. (See Attachments A-1 through A-10 for default versions.) The players should set up the map, using movable markers to indicate the locations of the units. They should plan the allocation and employment of their equipment to best support their forces and the coming operations. They should prepare a list of the equipment assignments and may want to prepare network diagrams.

The players should not go past this logo until told to do so by the Umpire:

```
*********************************************************
*                                                       *
*     ****     ****     *     *    ******    *          *
*    *    *   *    *    **   **    *         *          *
*    *        *    *    *  *  *    *****     *          *
*    *    *   *    *    *     *    *         *          *
*     ****     ****     *     *    ******    ******     *
*                                                       *
*              ****     *****       ****                *
*             *    *    *    *     *                    *
*             *    *    *****       ****                *
*             *    *    *          *    *               *
*              ****     *           ****                *
*                                                       *
*********************************************************
```

Do not proceed past this point until told to do so by the
Umpire. When the Umpire tells you to go on, enter [C/R]



PLAYER OPERATION PHASE FLOW

Figure A-14

When the Operations Phase actually begins, assuming the players are starting a new game and not resuming one already in progress, the first step is to assign the equipment to the right units or locations. The equipment items will show up on the screen one at a time, with instructions. The entries to be made vary with the type of equipment. All entries should be in lower case (EX. 35th abn).

(1) Some equipment is fixed, such as large satellite ground terminals. For these items the players will be asked to name the permanent hex location. For Example:

```
vlf is fixed equipment. Input the permanent location: xx xx
54 26
```

They input the row number and column number, separated by a comma or a blank space. (With the numbering system described in Section 1.4, each hex identification is either two odd or two even numbers.) Once the system is assigned to a hex location, it can be used by any unit in that hex, except that a VLF system may be used only by the Joint Task Force Headquarters to contact the National Command Authority. As players locate each piece of fixed equipment they may want to place a marker on their map.

(2) Some equipment is mobile, such as HF systems. The players will be given two choices:

artac 1 is mobile equipment that can

1. Be attached to a combat unit and move with it.
2. Be detached and set up as a separate comm relay or EW unit.

It will then move as a unit but have no combat points.

Input mision number 1 or 2.

For the first alternative, a typical enquiry and response are:

What unit do you want to attach it to? 354 mech

For the second alternative, players must select an initial location for the detachment, give it a name, and place a marker on the map. For example:

Locate the equipment by entering the hex number xx xx. 34 12
Input a name for the comm relay or EW detachment you have just established. Use up to 8 spaces. det 8

(3) Airborne command posts fly on a rotating schedule. Percent of availability depends on the number of aircraft purchased. If one side has bought only one ABNCP, it is available only 45% of the time. If they have bought two, one will be available 75% of the time. With three or more, an ABNCP will be scheduled for flight 100% of the time. However, the scheduled aircraft may develop unscheduled maintenance problems and be unable to fly or have radio equipment out and be unable to communicate. These problems are random, and are based on the C3E of the

aircraft scheduled to fly. The players are given the percent of availability, but make no decisions on use at this time. They will have an opportunity to assign orbit locations during each turn. The following information is displayed here:

```
You have       2 ABNCP.

ABNCP will be available 0.8500000 of the time. Orbit
assignments will be made in the COMM module of each turn.

Type any character to proceed.
```

(4)AWACS aircraft are scheduled like the ABNCPs. The terminal display is also the same.

(5) Communications satellites in the game have either one area beam or several spot beams. The players will be asked to input the initial center-focus for each beam. Changes can then be made each turn. Ground terminals will not be able to connect to the satellite unless they are within the beam (a circle of radius CRNG around the beam center). For example:

```
sat 1 is a comm satellite with 2 spot beams
each having a footprint of radius          6.
Each beam center can be relocated once each
turn.

Input the hex location of each beam center as
it is called for.

Enter the center of beam       1     20 30
Enter the center of beam       2     35 47
```

(6) Intelligence satellites can survey a certain number of sequential columns in each turn. For example, a satellite with range, or beamwidth, of 5 could survey columns 22,23,24,25, and 26 and identify the location of enemy units in those columns. Players can select the columns surveyed each turn, but make no decisions now. If they are working properly (based on C3E of the satellite), the satellite will always detect any enemy units in the columns surveyed. They will give the location but not the name of the unit. The following information is displayed:

```
spy 2 is an intelligence satellite that can survey     5
columns of hexes each turn. The track of the satellite is
chosen in the RECON module. Type any character to continue.
```

(7) Anti-satellite weapons also require no decisions now. They are one-shot weapons that can be directed against either communications or intelligence satellites. Their use must be approved by the NCA. The following information is displayed here:

```
atksat 1 is an anti-satellite weapon that can be used only
once. Use of the weapon is selected in the ATKSAT module.
Type any letter to proceed.
```

4.6 THE OPERATIONS TURN

Each turn consists of four parts: Intelligence Report, Player Action Menu, Movement, and Combat. All entries must be lower case. Each turn has a maximum time length, set by the Umpire. However, if both players finish before time is up the next turn will begin immediately.

4.6.1 Intelligence Report

In all turns except the first, players receive information from any satellite surveys or reconnaissance flights requested in the last turn. For example:

```
A recon flight has found an enemy unit in hex 24 30
An intelligence satellite indicates an enemy in hex 30 28
```

They will also receive lines of bearing to emitters from any EW equipment in the ESM mode and within range of the emitters. For example:

```
ESM indicates enemy emitters compatible with EW 3a
at an bearinge of 95 degrees true from 36 54
```

4.6.2 The Action Menu

The Player Action Menu is where the players make most of their decisions.

```
                    Action Menu

      1. Review Position and Goal Data
      2. Set/Change Goal for a Unit
      3. Change Electronic Equipment Missions
      4. Assign Recon Missions
      5. Assign Other Air Missions
      6. Embark/Disembark Marine Forces
      7. Airlift Airborne Forces
      8. Employ Anti-satellite Weapons
      9. Finished Turn

 Enter the number of your chosen action.
```

Players may make most of these options as many times as they wish until "Finished Turn" is selected or until the time limit runs out. The following paragraphs describe each option. Only a few of the many possible choices are shown. Most options include logical error checks that print

different statements if you make an incorrect entry, such as trying to airlift an armored brigade or land the Marines in the middle of the sea.

(1) "Review Position and Goal Data" allows the players to verify or update their map and to check the current goal and combat points of their units.

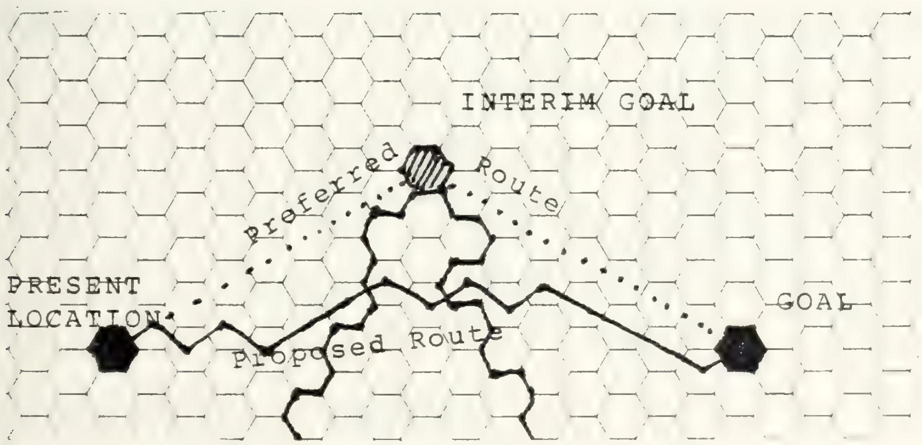
(2) "Set/Change Goal for a Unit" asks the player to input the name of the unit whose destination is to be changed. There is a communications check from the JTFHQ to the unit to see if a change of orders can get through; if so the present goal is displayed. The players input the new goal for the unit; and after a short delay a projected route is displayed. The projected route is computed by an optimum path routine which considers the type of unit and the terrain. The estimated length of the path, in movement points, is given, but the actual movement may be slowed by poor internal communications. If the players do not like the projected route, they can alter it by entering a new, closer goal along their preferred route. For example, if they want a unit to go through some woods, even if that route is slower, they could input an interim goal position. When the unit arrived at the interim position, they could

input orders to the final destination. An example of an exchange of queries is:

```
Which unit goal do you want to set or change?
Enter the units name - up to 8 spaces.  234 mech
The goal for 234 mech is now 0 0  Is this ok as is?
y or n
n
What is the desired goal?
Use 0 0 to stop the unit in its present position.
23 37
The goal of the unit has been changed to 23 37
There will be a short delay while the route is
being planned.

The projected path is:
19 29   18 30   17 31   16 32   15 33   17 33   18 34
19 35   21 35   22 36   23 37
this path will take about 10 movement points. If you
want to take a different route, resubmit a closer,
interim goal for this unit.
```

A sample projected path and an interim goal are shown in Figure A-15.



GOAL SETTING

Figure A-15

(3) "Change Electronic Equipment Missions" offers another menu:

```
        COMM MENU
   1. Assign ABNCP and AWACS orbits
   2. Detach equipment for use as a relay or EW unit
   3. Change comm satellite orbit
   4. Change EW system mission
   5. Return to main menu
Input number of desired action.
```

The first choice returns the percent of availibility for the ABNCP and AWACS and whether one is ready for use this turn. If one is available the players are asked to enter the orbit center. The aircraft will orbit during combat to relay orders and reports between the combat units and the JTFHQ. For example:

```
ABNCP is available 0.8500000 of the time.
One is available this turn. Input requested orbit
center xx xx. 30 40
```

The second choice allows the player to detach a piece of mobile electronic gear from a unit and set it up as a separate detachment. Players are asked for the equipment and assigned unit; if a match is found, they are asked for a name for the new detachment. When formed, a detachment has zero combat points. It cannot rejoin a combat unit later in the game. For example:

```
Enter the equipment you want detached.
wbs 2
Enter the unit that the equipment is presently assigned to.
345 arbg
What is the unit name for the new comm relay or EW detachment?
det 7
```

The third choice returns the center focus for each

communications satellite beam. The player can echo or change the location. A beam center selection remains in effect for subsequent turns until changed by the player. An example of this choice is:

```
sat 1 beam center is now located at 30 20
Enter the new location xx xx. 25 35
```

The fourth choice allows the player to designate the mission for each piece of EW equipment to be ECM or ESM. The designation will remain in effect for subsequent turns unless this choice is made again later.

(4) "Assign Recon Missions" allows the players to request satellite surveys or air reconnaissance missions.

```
Recon support requests:
    1. Satellite recon
    2. Air recon
    3. Return to main menu
Enter the number of the recon type requested.
```

If players ask for satellite surveys, they see a list of their intelligence satellites and are then asked to input the westernmost (left) column to be surveyed. For example:

```
You have the following intelligence satellites available:
spy 1  which can survey  1 adjacent columns per turn.
spy 1  which can survey  1 adjacent columns per turn.
spy 2  which can survey  2 adjacent columns per turn.

spy 1 is an intelligence satellite that surveys 1
adjacent columns each turn. Input the westernmost
column to be surveyed.  3

spy 1 is an intelligence satellite that surveys 1
adjacent columns each turn. Input the westernmost
column to be surveyed.  17
```

spy 2 is an intelligence satellite that surveys 2 adjacent columns each turn. Input the westernmost column to be surveyed. 30

If they ask for recce flights, the air wings can supply the flights only at the expense of other missions. Each air wing can do one recce mission per turn. Players must input the start and stop points of the photo flight, which can be up to 20 hexes long. For example, the sequence:

Any air recon you request will take priority over other air missions, so use them with care. Each air wing will do only one recce mission a turn.

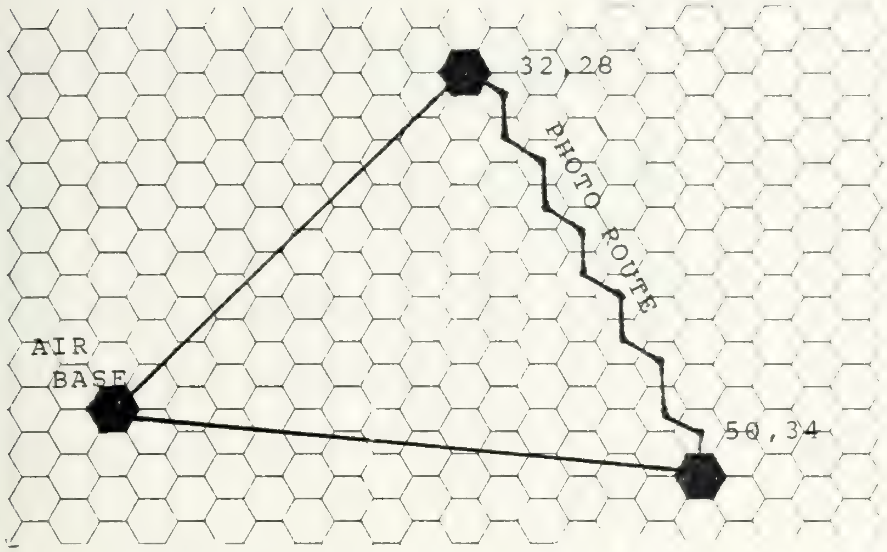
Each air recon mission will be a triangle flown from an air base to a designated point, then turning toward another designated point, then returning to the base. Recon photos will be taken only on the point-to-point leg of the flight. That leg may be no longer than 20 hexes and will not necessarily be a straight line.

Enter the beginning if the photo run - the first designated turning point - xx xx. 32 28
Enter the end of the photo run - the second designated turning point - xx xx. 45 31
Which tactical air wing do you want to fly the mission? 21st tfw

Would result in the recce flight path shown in Figure A-16.

(5) "Request Other Air Missions" gives the players a choice of interdiction, close air support, or counter air missions for each air wing. For example:

Each air wing, including carrier based wings can be configured each turn for interdiction, counter air, or close-air-support missions. Mission selections made here will supercede any made earlier this turn for the same units.



AIR RECONNAISANCE MISSION

Figure A-16

```
What mission do you want for 21st tfw?
     1. Interdiction
     2. Close-air-support
     3. Counter air
     4. No new mission
Enter the number of the mission. 2

Effectiveness of close-air-support will depend on comm links
between  the ground unit needing support, the JTFHQ, and the
air wing, as well as on air-to-air  support  and  enemy  air
defense.
```

If the players select interdiction they must input five target locations based on their intelligence information, such as:

```
What mission do you want for 64th tfw?
     1. Interdiction.
     2. Close-air-support
     3. Counter air
     4. No new mission
Enter the number of the mission.  1
```

Depending on such factors as communications, EW, enemy air defense, and air-to-air support, the wing has capability for a max of 5 strikes per turn.

Depending on the Rules of Engagement, higher headquarters approval may be needed for the attacks.

```
Give the hex row and column for strike priority 1 xx xx.
45 53
Give the hex row and column for strike priority 2 xx xx.
7 55
Give the hex row and column for strike priority 3 xx xx.
17 52
Give the hex row and column for strike priority 3 xx xx.
18 53
Give the hex row and column for strike priority 3 xx xx.
18 51
```

(6) "Embark/Disembark Marine Forces" offers the players a choice of either embarking a Marine Brigade onto an Amphibious Task Force or disembarking a brigade onto an adjacent shore hex. The menu looks like:

```
Do you want to:
    1. Embark an amphibious unit?
    2. Debark an amphibious unit on an adjacent shore?
    3. Return to main menu
Enter number of choice.
```

The locations of the Marine Brigade and the ATF must be appropriate (adjacent shore and sea hexes) before any action can take place. An embarkation request would look like this:

```
What unit do you want to embark?  7th mab
7th mab has embarked on 18th atf
```

Disembarking would require the following exchange:

```
Enter the Marine unit you wish to disembark. 7th mab
7th mab has begun landing on the shore in hex 23 41
```

(7) "Airlift Airborne Forces" allows the airdrop of one airborne unit per turn. The unit must be already located on an airfield. The player is asked for the name of the unit to be airdropped and the hex location. For example:

```
Enter the name of the unit to be airdropped. 75 abn
75th abn is loaded and ready to go.
Enter the hex location of the drop zone. xx xx
30 30
```

(8) "Finished Turn" notifies the control module that this side is ready to proceed.

4.6.3 Movement

After both players have completed their inputs, or time for that turn expires, the control module randomly selects one side to move first. Each unit is moved as far along its proposed path as its movement points allow. Each type of unit starts out with a given number of points; a fixed unit, such as an airfield, may have been given a goal, but it won't move because it has 0 movement points. An armor unit will move about 8 hexes per turn in open terrain, but mountains, rivers, and woods will slow it down and roads will let it move faster. Speed of movement will also be affected by effectiveness of the unit's internal communications.

As a unit moves toward its goal, it will stop immediately if it comes into the control zone of an enemy unit. (A control zone for a unit is its own hex and all six adjacent hexes.) Players will be notified of the situation and be given four choices: (a) they can order the unit to retreat along its approach path (if it has any movement points left), (b) they can stop the unit and go into a defensive posture, (c) they can continue toward their goal in a defensive posture (if they have the points), or (d) they can stop the unit and request approval of an attack. The request for attack approval automatically includes a request for close air support, if available.

4.6.4 Combat

The Umpire, acting as the National Command Authority sets the Rules of Engagement for a turn at one of three levels: (a) The NCA must approve all attacks; (b) The JTF Commander may approve attacks; and (c) The local commanders may attack targets of opportunity.

The first step of combat is interdiction. IF approval for strikes is required by the rules of engagement, a communications path must be established before the request can be transmitted. If NCA approval is required, the Umpire makes the decision. If the players have requested any reconnaissance missions, they are subtracted from any interdiction requests. Remaining aircraft take off toward their targets. If the enemy has AWACS aircraft up, they

will detect the strike force in time to call up interceptors, otherwise interceptors will not arrive until after the interdiction aircraft have dropped their bombs and headed home. If the aircraft get through to the target area, they will come up against the air defenses of the enemy units in the area. If they get through the air defenses, they will seriously damage any enemy units in the target hex. Players will receive reports on the success or failure of the interdiction attacks. A typical report might be:

Interdiction was successful against enemy in hex 35 57

The aircraft returning from the raid on 35 57 suffered serious losses due to enemy fighter attacks.

In the second stage of the combat sequence, jammers are turned on and the effectiveness of any susceptible equipment in range will be degraded. For example, EW 3a is effective at a range of up to 10 hexes against WBS 1. Within that range the effectiveness of the WBS 1 would be reduced from .787 to .394 (assuming no terrain effects).

The final stage is ground combat. Which side has the advantage of making the first attack is decided by random selection, but a general priority is followed. First, units arriving in the area of a stationary unit get the attack/defense/continue/retreat option, then the stationary unit. If the players decide to attack, they may

need approval from headquarters, depending on the rules of engagement. If the NCA is retaining control, the communications links from the unit to the JTFHQ and from there to the NCA are checked. Then the Umpire makes the decision. If the NCA has given control to the JTF Commander only the unit to JTFHQ link must be checked. If battlefield control has been given to the local commanders, no communications checks are required and any request is automatically approved. If approval is refused or the requests cannot get through, the unit automatically goes into a stationary defensive posture.

If an attack is approved and begun, electronic warfare equipment in the ESM mode will add to the unit's combat value, since the commander will have a better picture of the battlefield.

If the attack is made across a river, the defender has an advantage.

Close air support missions will then be called up by the attacking unit. Effectiveness of the close air support depends on the enemy's air defense capability, the ability of the aircraft to overcome the defenses (by jamming the radar controls of anti-aircraft weapons), and by the internal communications of the air unit and forward air controllers. Players will be told the outcome of the air support mission; for example:

Close air support was requested by 432 arbg but was unable to get through enemy air defenses.

Players will then be told the combat values of their units as ground combat begins (after the above effects are calculated). For example:

As a result of EW efforts of both sides and the terrain, 398 abn will attack the enemy unit in hex 34 54 with an effective combat value of 4.2

The results of the ensuing ground battle depend on the difference in remaining combat values and on a random number. Results of the combat are reported in three areas: a unit may take personnel losses, lowering the combat value; it may be forced to retreat; and it may have some electronic equipment damaged. The outcomes are based on a combat results table. (The default table is in Attachment A-11.) Players will be informed of the outcome; for example:

As a result of combat, 345 cbg has lost 2.0 combat points.

The unit was forced to retreat 3 hexes and is now located in 10 23.

As a result of combat, the hftty2 assigned to 345 cbg has been damaged and is no longer usable.

If a unit sets up a defensive position and is never attacked, it will still lose some combat effectiveness because the extended vigilance will exhaust the troops.

4.6.5 <u>End of Game</u>

The game turn sequence will repeat until one side achieves a complete victory or until the controller decides

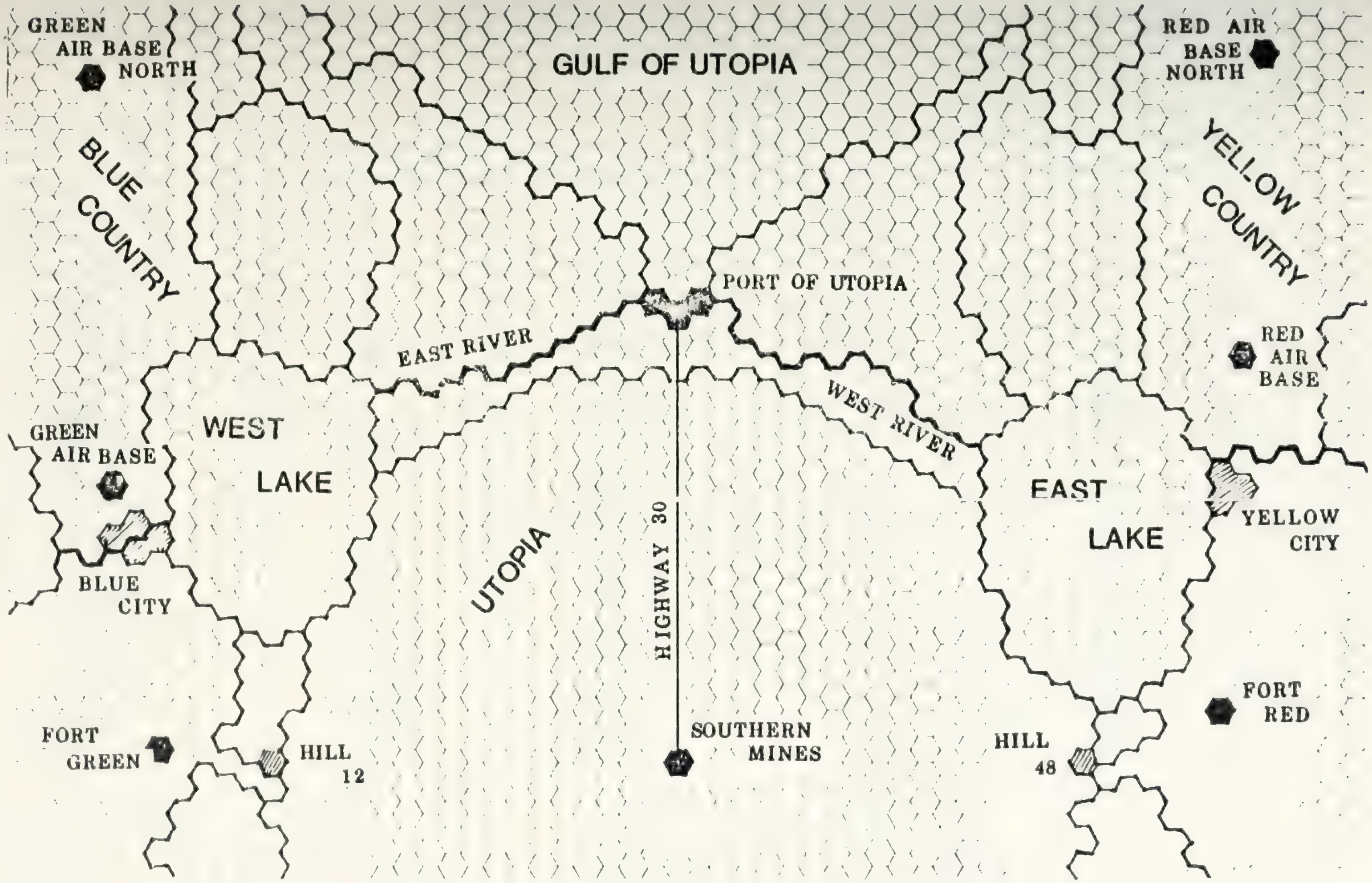
to end the game or call a cease fire (in which case the game may be resumed at another time). There are several possible outcomes for the game:

(a) one side wins a decisive victory if they control all the major and minor objectives;

(b) they have a marginal victory if the game ends with them controlling all major objectives while their opponent controls no objectives;

(c) if one side controls all major objectives and the other controls some minor objectives, the NCA (controller) can decide on a negotiated settlement, with or without a declared victor;

(d) If neither side controls all major objectives, the NCA may call for a cease fire with no victor.



THE DEFAULT MAP

Attachment A-1

Attachment A-2a

DEFAULT SYSTEMS ACQUISITION DATA

#	SYSTEM	NOA	RDCOST	RDTIME	ARDCST	ARDTIM	MDCOST	MDTIME	OMCOST	ROMCST
1	artac 1	4	0	0	0	0	12	1	8	4
2	artac 2	4	10	3	25	2	24	1	9	5
3	navtac 1	3	0	0	0	0	12	1	8	4
4	navtac 2	3	10	3	25	2	25	1	10	5
5	aftac 1	2	0	0	0	0	13	1	9	5
6	aftac 2	2	10	3	25	2	26	1	9	5
7	hftty 1	14	0	0	0	0	5	1	4	2
8	hftty 2	14	7	2	15	1	10	1	5	3
9	wbs 1	11	0	0	0	0	8	1	5	3
10	wbs 2	11	8	4	24	2	14	1	8	4
11	shf-sat	1	7	4	16	3	17	1	9	4
12	shf-gt	10	3	4	7	3	10	1	6	3
13	vlf	1	8	2	24	1	44	2	12	6
14	tritac	2	3	2	16	1	20	1	9	5
15	tritaceh	2	7	3	22	2	26	1	9	5
16	sat 1	1	0	0	0	0	12	1	11	6
17	gt-sat 1	1	0	0	0	0	12	1	11	6
18	sat 2	1	10	4	30	2	24	1	5	8
19	gt-sat 2	4	5	4	10	2	8	1	5	2
20	sat 3	1	15	4	30	3	27	1	15	9

NOA = Number available
RDCOST = R+D Cost in Megabucks
RDTIME = R+D Time in Years
ARDCST = Accelerated R+D Cost
ARDTIM = Accelerated R+D Time

MDCOST = M+D Cost
MDTIME = M+D Time
OMCOST = Normal O+M Cost
ROMCST = Reduced O+M Cost

Attachment A-2b

DEFAULT SYSTEMS ACQUISITION DATA (Continued)

#	SYSTEM	NOA	RDCOST	RDTIME	ARDCST	ARDTIM	MDCOST	MDTIME	OMCOST	ROMCST
21	gt-sat 3	4	7	4	12	3	8	1	5	3
22	singars	1	11	4	30	2	31	2	11	5
23	singargt	9	5	4	10	2	9	2	4	2
24	abncp 1	6	5	1	99	99	18	1	8	4
25	abncp 2	6	8	2	24	1	25	2	8	4
26	awacs	6	4	1	99	99	23	1	10	5
27	awacs-eh	6	6	2	20	1	28	2	10	5
28	spysat 1	3	6	2	99	99	15	1	5	3
29	spysat 2	2	8	2	99	99	19	1	6	3
30	atksat 1	5	8	2	99	99	16	1	8	5
31	atksat 2	5	10	2	99	99	20	1	9	5
32	ew 1	5	3	1	99	99	8	1	5	3
33	ew 2	5	5	3	15	2	14	1	7	4
34	ew 3	5	7	2	20	1	15	1	8	4
35	ew 3a	3	8	3	32	1	22	1	10	6
36	ew 4	8	5	2	15	1	12	1	6	3
37	ew 4a	6	8	2	22	1	15	1	10	6
38	ew 5a	8	10	3	35	1	25	1	12	6

NOA = Number available
RDCOST = R+D Cost in Megabucks
RDTIME = R+D Time in Years
ARDCST = Accelerated R+D Cost
ARDTIM = Accelerated R+D Time
MDCOST = M+D Cost
MDTIME = M+D Time
OMCOST = Normal O+M Cost
ROMCST = Reduced O+M Cost

Attachment A-2c

DEFAULT SYSTEMS TECHNICAL DATA

#	SYSTEM	ETYPE	MOB	CRNG (BMWD)	CRNGS	SEC	REL	RELS	FLEX	OPT	C3E	C3ES
1	artac 1	tac	7	3	1		0.780		0.750	0.880	0.714	
2	artac 2	tac	8	4	3		0.950		0.900	0.950	0.900	
3	navtac 1	tac	7	3	1		0.820		0.830	0.880	0.775	
4	navtac 2	tac	8	5	3		0.960		0.920	0.960	0.922	
5	aftac 1	tac	7	3	1		0.830		0.830	0.860	0.922	
6	aftac 2	tac	8	5	3		0.950		0.910	0.950	0.906	
7	hftty 1	hf	8	6	9999	2	0.930	0.680	0.825	0.880	0.550	0.608
8	hftty 2	hf	8	9	9999	3	0.980	0.680	0.883	0.900	0.690	0.693
9	wbs 1	los	7	35	2		0.850		0.830	0.880	0.787	
10	wbs 2	los	8	50	3		0.900		0.900	0.930	0.866	
11	shf-sat	sat	999	9999	1	4	0.990		0.850	0.800	0.67	
12	shf-gt	gtsat	8	9999	4		0.990		0.850	0.800	0.819	
13	vlf	vlf	0	9999	3		0.980		0.850	0.950	0.610	
14	tritac	sw	4	0	4		0.990		0.980	0.980	0.950	
15	tritaceh	sw	5	0	4		0.990		0.990	0.990	0.970	
16	sat 1	sat	999	9999	1	1	0.850		0.800	0.900	0.610	
17	gt-sat 1	gtsat	0	9999	1		0.850		0.800	0.900	0.781	
18	sat 2	sat	999	9999	1	2	0.950		0.900	0.900	0.770	
19	gt-sat 2	gtsat	0	9999	2		0.950		0.900	0.900	0.877	
20	sat 3	sat	999	10	4	4	0.850		0.980	0.900	0.770	

ETYPE = Equipment type
MOB = Mobility (Movement points)
CRNG(BMWD) = range(beamwidth of satellites)
CRNGS = range of HF in skywave mode
SEC = Security Factor (resistance to EW)

REL = Reliability
RELS = Rel. of HF in skywave
FLEX = Flexibility
OPT = Operability
C3E = C3 Effectiveness

Attachment A-2d

DEFAULT SYSTEMS TECHNICAL DATA (Continued)

#	SYSTEM	ETYPE	MOB	CRNG (BMWD)	CRNGS	SEC	REL	RELS	FLEX	OPT	C3E	C3ES
21	gt-sat 3	gtsat	0	10	4		0.850		0.980	0.900	0.866	
22	singars	sat	999	6	6	5	0.950		0.980	0.930	0.780	
23	singargt	gtsat	8	6	5		0.950		0.980	0.930	0.883	
24	abncp 1	abncp	999	40	3		0.800		0.850	0.800	0.540	
25	abncp 2	abncp	999	9999	4		0.880		0.930	0.830	0.760	
26	awacs	awacs	999	9999	3		0.880		0.800	0.830	0.580	
27	awacs-eh	awacs	999	9999	4		0.950		0.850	0.830	0.670	
28	spysat 1	spy	999	1	2		0.880		0.830	0.850	0.620	
29	spysat 2	spy	999	2	3		0.980		0.900	0.850	0.750	
30	atksat 1	asat	0	9999			0.950		0.850	1.000	0.810	
31	atksat 2	asat	0	9999			0.970		0.900	1.000	0.870	

ETYPE = Equipment type
MOB = Mobility (Movement points)
CRNG(BMWD) = range(beamwidth of satellites)
CRNGS = range of HF in skywave mode
SEC = Security Factor (resistance to EW)

REL = Reliability
RELS = Rel. of HF in skywave
FLFX = Flexibility
OPT = Operability
C3E = C3 Effectiveness
C3ES = Eff. of HF in skywave

Attachment A-2e

EW SYSTEMS TECHNICAL DATA

#	SYSTEM	ETYPE	MOB	CRNG	EWV	ECM	ESM
32	ew 1	ew	8	4	6	-0.400	2
33	ew 2	ew	8	5	8	-0.500	2
34	ew 3	ew	6	6	7	-0.500	1
35	ew 3a	ew	99	10	10	-0.600	1
36	ew 4	ew	8	4	7	-0.500	1
37	ew 4a	ew	99	4	10	-0.500	1
38	ew 5a	ew	99	3	10	-0.750	1

ETYPE = Equipment type
MOB = Mobility
CRNG = Range
EWV = EW value, ability to overcome security of comm systems, larger number is better
ECM = Jamming power, effect on comm systems C3E, a smaller, more negative number is better
ESM = ability to detect and intercept comm systems,a larger number is better

DEFAULT COMPATIBILITY TABLE

System Numbers (from system list)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	CA
1	T		T		T									W	W									T		T						T	T						
2		T		T		T								W	W										T		T					T	T						
3	T		T		T									W	W									T		T						T	T						
4		T		T		T								W	W										T		T					T	T						
5	T		T		T									W	W									T		T						T	T						
6		T		T		T								W	W										T		T					T	T						
7							T							W	W									T		T										T	T		T
8								T						W	W										T		T									T	T		T
9									T					W	W									T		T								T	T				
10										T				W	W										T		T							T	T				
11												T													T													T	
12											T	T			W					T																			
13													T	W	W																								T
14	W	W	W	W	W	W	W	W	W	W			W	W			T		T																				
15	W	W	W	W	W	W	W	W	W	W		W	W		W		T		T		T		T																
16																	T							T															T
17														G	G	T																							
18																			T						T														T
19														G	G			T																					
20												T									T				T													T	T
21															G					T																			
22																							T		T								T						
23															G							T																	

BLANK = NOT COMPATIBLE　　W = COMPATIBLE ONLY THROUGH WIRE CONNECTION
T = COMPATIBLE　　G = COMPATIBLE ONLY IN SAME HEX

Attachment A-3a

SYSTEM INFORMATION

Service Tactical Communication systems (tac) are designed for internal unit comm in support of unit operations. They are compatible with other tactical comm systems of the same generation (when in range).

High Frequency Systems (hf) can be used in both surface and skywave modes of propagation. Each system is compatible with the airborne comm systems of the same generation.

Wide Band systems are compatible with airborne comm systems within range and type restrictions. They are line-of-sight systems (los).

Switching Systems (sw) interface comm systems into the unit command center. They are normally used only at the JTFHQ.

Satellite systems consist of a satellite (sat) and fixed earth terminals (gtsat). Each system may be compatible with either an airborne comm platform or other satellite systems. The SINGGARS system provides very mobile single channel comm between distant tactical units but is limited in compatibility to the ABNCP II. The SHF system consists of a satellite and mobile earth terminals. The SHF earth terminals may also use the SATCOM III satellite.

VLF System (vlf) is a Very Low Frequency System designed to provide anti-jam comm with the NCA.

Airborne Command Posts (abncp) are airborne comm platforms that can interface with a large number of other comm systems to provide redundancy and a greater range capability.

Airborne Warning Control System (awacs) provides some interface with other comm systems as well as an advanced radar warning system which detects enemy aircraft movement.

Attachment A-3b
SYSTEM INFORMATION (Continued)

Intelligence satellites (spy) are used to detect ground movement. The SPYSAT I can detect movement in a 1 hex strip. SPYSAT II can detect movement in a 2 hex strip. Each satellite may be positioned once during each Operation turn.

Anti-Satellite Systems (asat) are not comm systems. They are weapons systems to be used against enemy intelligence satellites and enemy communications satellites. ATK SAT may be used only once and their use must be approved by the NCA.

EW systems (ew) are ground-mobile systems effective against various types of comm systems. The EWF of a system measures its ability to overcome the security of communications systems. ECM measures its jamming power, or effect on the comm system's C3E. ESM measures its ability to detect and intercept comm systems.

Attachment A-3b

Attachment A-4

RED DEFAULT UNITS

unitname	type	location	mob	ewv	casv	cav	adno
jtfhq	jtfhq	54 54	4	0	0	0	6
24th tfw	tfw	4 56	0	6	6	4	4
86th tfw	tfw	29 55	0	6	4	6	4
7th cbg	cbg	3 39	8	0	0	0	4
21 atf	atf	5 43	8	6	4	6	6
8th mab	amph	6 44	6	0	0	0	5
297 arbg	armor	29 55	8	0	0	0	4
81 arbg	armor	54 54	8	0	0	0	4
41 mech	mech	54 54	8	0	0	0	4
8th abn	abn	4 56	4	0	0	0	3

GREEN DEFAULT UNITS

unitname	type	location	mob	ewv	casv	cav	adno
jtfhq	jtfhq	57 7	4	0	0	0	6
6th tfw	tfw	6 4	0	6	6	4	4
31st tfw	tfw	37 5	0	6	4	6	4
4th cbg	cbg	2 22	8	0	0	0	4
64th atf	atf	5 15	8	6	4	6	6
6th mab	amph	6 14	6	0	0	0	5
437 arbg	armor	57 7	8	0	0	0	4
194 arbg	armor	37 5	8	0	0	0	4
37 mech	mech	57 7	8	0	0	0	4
87 abn	abn	6 4	4	0	0	0	3

TYPE = Unit type
Location = Hex row and column
Mob = Mobility, Movement points
EWV = EW value, ability of an air wing to overcome enemy
air defense by jamming weapon control radar
CASV = Close air support capability of air wing
CAV = Counter air value of air wing
ADNO = Air defense value of ground unit

Attachment A-5

INITIAL DEFAULT EQUIPMENT LISTS FOR ACQUISITION PHASE

RED EQUIPMENT			GREEN EQUIPMENT		
End Item	System	Number	End Item	System	Number
artac 1	1	1	artac 1	1	4
navtac 1	3	2	hftty 1	7	6
aftac 1	5	2			
wbs 1	9	2			
sat 1	16	1			
gt-sat 1	17	2			

Attachment A-6

DEFAULT EQUIPMENT FOR OPERATIONS PHASE

RED EQUIPMENT

End Item	System	Number
artac 1	1	1
artac 2	2	4
navtac 1	3	3
aftac 1	5	2
hftty 2	8	12
wbs 1	9	6
shf-sat	11	1
shf-gt	12	3
vlf	13	1
tritac	14	1
sat 1	16	1
gt-sat 1	17	3
singars	22	1
singargt	23	3
abncp 1	24	3
awacs	26	1
awacs-eh	27	2
spysat 2	29	2
atksat 1	30	3
ew 1	32	3
ew 3a	35	1
ew 5a	38	1

GREEN EQUIPMENT

End Item	System	Number
artac 1	1	4
artac 2	2	1
navtac 2	4	3
aftac 2	6	2
hftty 1	7	12
wbs 2	10	6
shf-gt	12	6
vlf	13	1
tritaceh	15	1
sat 3	20	1
gt-sat 3	21	3
abncp 2	25	2
awacs	26	4
spysat 1	28	2
atksat 1	30	1
atksat 2	31	2
ew 2	33	5
ew 3	34	1
ew 4a	37	1

Attachment A-7

CINCRED CONPLAN 4123 (U) [Ref. 1]
PLAN SUMMARY (U)

1. PURPOSE: This CONPLAN fulfills a task assignment in the Joint Strategic Capabilities Plan (JSCP). The purpose to be achieved by executing this plan is to ensure a continued supply of critical resource X for Country RED. This will be accomplished by employing a Joint Task Force (JTF) to seize and occupy the Southern Mines in UTOPIA and the Port of Utopia.

2. CONDITIONS OF EXECUTION: UTOPIA remains a neutral country with no regular military forces of its own. UTOPIA also refuses to have any military forces of other countries stationed on its soil. Our violation of UTOPIA's neutrality must take place only as a last resort. Therefore, execution of this plan will be considered only if worldwide shortages of critical resource X occur and intelligence sources reveal that invasion of UTOPIA by Country GREEN is imminent.

3. OPERATIONS TO BE CONDUCTED: Rapid response is essential and can best be achieved by maintaining prepositioned combat-ready forces as close to UTOPIA as possible. Consequently, this plan will be carried out by our forces now stationed in Country YELLOW which borders on UTOPIA.

a. Deployment. To preclude a strong reaction from Country GREEN and avoid criticism from the world community, we will not significantly increase our military presence in Country YELLOW. We will, however, insure that the units already stationed there achieve full combat strength. As much as possible, we will upgrade their combat and support capabilities. Additional support to our ground and air forces in Country YELLOW will be provided by a carrier task force including marine amphibious forces. This task force will be dispatched to the Gulf of Utopia prior to full execution of the plan.

b. Employment. When the carrier task force reaches the Gulf of Utopia, our ground forces in Country YELLOW will initiate the offensive. If Country GREEN attacks first, our ground forces will immediately respond without waiting for the carrier task force. The following pages summarize the preferred course of action. If we take the offensive, we will execute the preferred course of action. However, if Country GREEN attacks first, our course of action will depend on the situation.

PREFERRED PLAN

Armored brigade B and the mechanized infantry brigade will proceed from Fort RED through Yellow Mountain Pass toward the Southern Mines of Utopia. Once this objective is secured, armored brigade B will proceed toward Blue Mountain Pass to intercept advancing enemy units. To minimize the time required to reach the Port of Utopia, armored brigade A from Fort RED will move north and take up a position within the forest to the east of the Port of Utopia. This unit should be in place before any of our forces cross the border into Utopia. When the carrier task force arrives, a marine amphibious brigade will come ashore east of the Port of Utopia. They will assault the port with the support of armored brigade A moving westward from the forest. The first combat element to move into UTOPIA will be the airborne brigade from RED AB. They will be air dropped into a strategic area overlooking Blue Mountain Pass. From this location they will be able to effectively slow down the movement of enemy forces through the pass. They will later be reinforced by armored brigade B moving across to Southern Mines.

ALTERNATE PLAN

Two armored brigades and one mechanized infantry brigade will proceed from Fort RED through YELLOW Mountain Pass toward the Southern Mines of Utopia. Once this objective is secured, armored brigade A will proceed north along the highway toward the Port of Utopia. Armored brigace B will proceed toward Blue Mountain Pass to intercept advancing enemy units. When the carrier task force arrives, a marine amphibious brigade will come ashore east of the Port of Utopia. They will assault the port from the east while armored brigade A moves up from the south. The first comabat element to move into UTOPIA will be the airborne brigade from RED AB. They will be air dropped into a strategic area overlooking Blue Mountain Pass. From this location they will be able to effectively slow down the advance of enemy forces through the pass. They will later be reinforced by armored brigade B moving across from Southern Mines.

The foregoing summary of courses of action provides military decision-makers a brief recapitulation of the major aspects of this plan. It is based on planning factors and estimates available at the time of preparation, and is subject to modification in the context of a specific contingency. The information it contains should be reviewed, and, if necessary, updated before its use in adopting a course of action in a given situation. Each operations and support agency must prepare and maintain a five-year plan for the acquisition of new systems to support this plan. Include budget estimates.

4. TIME TO COMMENCE EFFECTIVE OPERATIONS. Combat units must achieve full combat readiness within the next two years. Internal communications of combat units must be reviewed and updated as necessary. The JTF HQ must be established and communications provided. Acquisition of systems to upgrade, as necessary, should be included in the five year plan. We anticipate military action in UTOPIA in the next two to six years.

5. COMMAND RELATIONSHIPS. The NCA will retain direct control of plan execution and combat operations. Operational chain of command will be from NCA to JCS to JTF HQ to combat units.

6. EXECUTION. Each operations and support agency must prepare and maintain a list of general actions necessary to place the plan into operation. If the plan had to be executed immediately, how could currently available resources best be employed?

Attachment A-8

CINCGREEN CONPLAN 4123 (U) [Ref. 1]
PLAN SUMMARY (U)

1. PURPOSE. This CONPLAN fulfills a task assignment in the Joint Strategic Capabilities Plan (JSCP). The purpose to be achieved by executing this plan is to ensure a continued supply of critical resource X for Country GREEN. This will be accomplished by employing a Joint Task Force (JTF) to seize and occupy the Southern Mines in UTOPIA and the Port of Utopia.

2. CONDITIONS OF EXECUTION. UTOPIA remains a neutral country with no regular military forces of it's own. UTOPIA also refuses to have any military forces of other countries stationed on it's soil. Our violation of UTOPIA's neutrality must take place only as a last resort. Therefore, execution of this plan will be considered only if worldwide shortages of critical resource X occur and intelligence sources reveal that invasion of UTOPIA by Country RED is imminent.

3. OPERATIONS TO BE CONDUCTED. Rapid response is essential and can best be achieved by maintaining prepositioned, combat-ready forces as close to UTOPIA as possible. Consequently, this plan will be carried out by our forces now stationed in Country BLUE which borders on UTOPIA.

a. Deployment. To preclude a strong reaction from Country RED and avoid criticism from the world community, we will not significantly increase our military presence in Country BLUE. We will, however, insure that the units already stationed there (two armored brigades, one mechanized infantry brigade, one airborne brigade, and two tactical flying units) achieve full combat strength. As much as possible, we will upgrade their combat and combat support capabilities. Additional support to our ground and air forces in Country BLUE will be provided by a carrier task force including Marine amphibious forces. This task force will be dispatched to the Gulf of UTOPIA prior to full execution of the plan.

b. Employment. When the carrier task force reaches the Gulf of Utopia, our ground forces in Country BLUE will initiate the offensive. If Country RED attacks first, our ground forces will immediately respond without waiting for the carrier task force. The following pages summarize the preferred course of action followed by two alternative courses of action. If we take the offensive, we will execute the preferred course of action. However, if Country RED attacks first, our course of action will depend on the situation.

PREFERRED PLAN

Two armored brigades and one mechanized infantry brigade will proceed from Fort Green through the Blue Mountain Pass toward the Southern Mines in UTOPIA. Once this objective is secured, one armored brigade will proceed north along the highway toward the Port of Utopia. The other armored brigade will proceed toward Yellow Mountain Pass to intercept advancing enemy units. When the carrier task force arrives, a marine amphibious brigade will come ashore west of the Port of Utopia. They will assault the port from the west while the armored brigade moves up from the south. The first combat element to move into UTOPIA will be the airborne brigade from Green AB. They will be air dropped into a strategic area overlooking Yellow Mountain Pass. From this location they will be able to effectively slow down the advance of enemy forces through the pass. They will later be reinforced by the armored brigade moving across from Southern Mines.

ALTERNATE PLAN

One armored brigade and one infantry brigade will proceed from Fort Green through Blue Mountain Pass toward the Southern Mines in UTOPIA. Once this objective is secured, the armored brigade will proceed toward Yellow Mountain Pass to intercept advancing enemy units. To minimize the time required to reach the Port of Utopia, one armored brigade from Fort Green will move north and take up a postion within the forest to the west of the Port of Utopia. This unit should be in place before any of our forces cross the border into UTOPIA. They will assault the port with the support of the armored brigade moving eastward from the forest. The first combat element to move into UTOPIA will be the airborne brigade from Green AB. They will be air dropped into a strategic area overlooking Yellow Mountain Pass. From this location they will be able to effectively slow down the movement of enemy forces through the pass. They will later be reinforced by the armored brigade moving across from Southern Mines.

The foregoing summary of courses of action provides military decision-makers a brief recapitulation of the major aspects of this plan. It is based on planning factors and estimates available at the time of preparation, and is subject to modification in the context of a specific contingency. The information it contains should be reviewed, and, if necessary, updated before its use in adopting a course of action in a given situation. Each operations and support agency must prepare and maintain a five-year plan for the aquisition of new systems to support this plan. Include budget estimates.

4. TIME TO COMMENCE EFFECTIVE OPERATIONS. Combat units must achieve full combat readiness within the next two years. Internal communications of combat units must be reviewed and updated as necessary. The JTF HQ must be established and communications provided. Acquisition of systems to upgrade, as necessary, should be included in the five-year plan. We anticipate military action within UTOPIA in the next two to six years.

5. COMMAND RELATIONSHIPS. The NCA will retain direct control of plan execution and combat operations. Operational chain of command will be from NCA to JCS to JTF HQ to combat units.

6. EXECUTION. Each operations and support agency must prepare and maintain a list of general actions necessary to place the plan into operation. If the plan had to be executed immediately, how could currently available resources best be employed?

Attachment A-9

Commanders's Planning Guidance - JTF RED [Ref. 1]

1. The current JSCP tasks us to be prepared to invade the Country of UTOPIA in order to secure a continuing supply of critical resource X. UTOPIA is the richest known source of this resource. Heavy reliance on foreign imports of resource X is expected to continue and worldwide shortages are predicted within five years. Our strongest ideological adversary, Country Green, is also heavily dependent on imports of resource X. Intelligence sources reveal that GREEN is also planning for possible military action in UTOPIA. Our mission is to gain control of UTOPIA's Southern Mines and the Port of Utopia.

2. Type of Operation. This will be a coordinated attack involving a main armored assault with supporting attacks by airborne and amphibious forces. A carrier task force will be postioned in the Gulf of Utopia to support the amphibious forces and defend against enemy naval attack. Country YELLOW which borders on UTOPIA has long been our ally. We have one army base and two tactical air bases in YELLOW that are near the UTOPIA border. We will utilize forces currently stationed in YELLOW for the initial assult.

Country BLUE which also borders on UTOPIA is expected to remain friendly to Country GREEN.

3. Phasing Instructions. Pre-execution preparations that have priority are:

a. Establish a JTF HQ. J6, plan communications to connect the JTF HQ with the NCA, Fort RED, RED AB, and RED AB North. Also, it is essential that deployed combat units have reliable communications with the JTF HQ. Request your recommemdation for the location of the JTF HQ within Country YELLOW.

b. Achieve combat capability as soon as possible. We must be able to support execution in two years. However, we must also plan for continued support of our forces. Insure that your planning covers the next five years and includes both equipment acquisitions and budget estimates.

4. Tentative Courses of Action if CONPLAN is Executed. J3 has provided the following courses of action for accomplishing the mission. Review these in conjunction with the map provided by J2:

a. Course of action #1. Main attack - Ground assault through YELLOW Mountain Pass by two armored brigades and one mechanized infantry brigade. Initial objective will be to seize and occupy Southern Mines. One armored brigade will then proceed north along the highway to the Port of Utopia

and one armored brigade will proceed to BLUE Mountain Pass. Supporting attacks - Amphibious assault on northern coast of UTOPIA by one marine amphibious brigade. Their objective is to seize and occupy the Port of Utopia in conjunction with the armored brigade moving up from Southern Mines. Simultaneous airborne assault on BLUE Mountain Pass by one airborne brigade. Their objective will be to delay enemy advance through BLUE Mountain Pass until armored brigade arrives from Southern Mines.

b. Course of action #2. Main attack - Ground assault through YELLOW Mountain Pass by one armored brigade and one mechanized infantry brigade. Their objective will be to seize and occupy Southern Mines. The armored brigade will then proceed to BLUE Mountain Pass. Supporting attacks - To minimize the time required to reach the Port of Utopia, one armored brigade from Fort RED will move north and take up a position within the forest to the west of the Port of Utopia. When the attack begins, the brigade will cross the border into UTOPIA and join a marine amphibious brigade for a combined assault on the port. Simultaneous airborne assault on BLUE Mountain Pass by one airborne brigade. Their objective will be to delay enemy advance through BLUE Mountain Pass until armored brigade arrives from Southern Mines.

5. Analysis of Relative Combat Power. According to latest intelligence, Country GREEN has the following forces tasked for operations in UTOPIA:

3 armored/mechanized brigades
1 airborne brigade
1 amphibious ready group
1 marine amphibious brigade
1 carrier task force
2 tactical fighter wings
1 JTF HQ
1 tactical air control system

The capability of enemy forces is presently comparable to our own. However, enemy plans for invasion of UTOPIA are unknown as are enemy plans for upgrading their joint task force.

6. NBC Warfare. We will not use nuclear, biological, or chemical weapons. Because we do not know enemy intentions, our forces must remain properly equipped and thoroughly trained for NBC defense.

7. Restrictions on Operations.

a. Close control by the NCA is necessary because of the danger of rapid escalation. Again, rapid and reliable communications are essential between the NCA and the JTF HQ.

b. Because of political considerations, we will not launch any strikes against forces located within the geographic boundaries of Country BLUE.

8. Pertinent Assumptions.

a. It is estimated that military action to ensure a continued supply of critical resource X will be necessary between two and six years in the future with six years being the more likely.

b. Country YELLOW will remain our ally and continue to allow us to maintain combat forces there.

c. Country BLUE will remain an ally of GREEN and GREEN will employ forces stationed in BLUE to support their operations in UTOPIA.

9. Essential Elements of Information.

a. General:

(1) Determine if and when the enemy is planning to invade the Country of Utopia.

(2) Determine if the enemy plans to employ NBC weapons.

b. J1, Personnel

(1) The attitude of the civilian populace within the area of operations.

(2) The amount of food and medical supplies available in the area of operations for distribution to the civilian populace when we secure the area.

c. J3, Operations

(1) Detailed up-to-date enemy order of battle.

(2) Location of enemy JTF HQ.

d. J4, Logistics

(1) Cross-country trafficability studies for wheeled and tracked vehicles.

(2) Location of indigenous POL facilities in area of operations.

e. J6, Communications-Electronics

(1) Availability and nature of enemy electronic jamming capability.

(2) Enemy satellite surveillance capability which can detect the movement of our forces.

10. Request that each directorate prepare their staff estimate. Include your determination of which proposed course of action can best be supported from your standpoint. J6, also include your recommendation for the location of the JTF HQ.

Attachment A-10

Commander's Planning Guidance - JTF GREEN [Ref. 1]

1. The current JSCP tasks us to be prepared to invade the Country of UTOPIA in order to secure a continuing supply of critical resource X. UTOPIA is the richest known source of this resource. Heavy reliance on foreign imports of resource X is expected to continue and worldwide shortages are predicted withing five years. Our strongest ideological adversary, Country RED, is also heavily dependent on imports of resource X. Intelligence sources reveal that RED is also planning for possible military action in UTOPIA. Our mission is to gain control of UTOPIA'S Southern Mines and the Port of Utopia.

2. Type of Operation. This will be a coordinated attack involving a main armored assault with supporting attacks by airborne and amphibious forces. A carrier task force will be positioned in the Gulf of Utopia to support the amphibious forces and defend against enemy naval attack. Country BLUE which borders on UTOPIA has long been our ally. We have one army base and two tactical air bases in BLUE that are near the UTOPIA border. We will utilize forces currently stationed in BLUE for the initial assault.

Country YELLOW which also borders on UTOPIA is expected to remain friendly to Country RED.

3. Phasing Instructions. Pre-execution preparations that have priority are:

a. Establish a JTF HQ. J6, plan communications to connect the JTF HQ with the NCA, Fort Green, Green AB, and Green AB North. Also, it is essential that deployed combat units have reliable communications with the JTF HQ. Request your recommendation for the location of the JTF HQ withing Country BLUE.

b. Achieve combat capability as soon as possible. We must be able to support execution in two years. However, we must also plan for continued upgrade of our forces. Insure that your planning covers the next five years and includes both equipment acquisitions and budget estimates.

4. Tentative Courses of Action if CONPLAN is Executed. J3 has provided the following courses of action for accomplishing the mission. Review these in conjunction with the map provided by J2.

a. Course of action #1. Main attack - Ground assault through Blue Mountain Pass by two armored brigades and one mechanized infantry brigade. Initial objective will be to seize and occupy Southern Mines. One armored brigade will then proceed north along the highway to the Port of Utopia

and one armored brigade will proceed to Yellow Mountain Pass. Supporting attacks - Amphibious assault on northern coast of UTOPIA by one marine amphibious brigade. Their objective is to seize and occupy the Port of Utopia in conjunction with the armored brigade moving up from Southern Mines. Simultaneous airborne assault on Yellow Mountain Pass by one airborne brigade. Their objective will be to delay enemy advance through Yellow Mountain Pass until armored brigade arrives from Southern Mines.

b. Course of action #2. Main attack - Ground assault through Blue Mountain Pass by one armored brigade and one mechanized infantry brigade. Their objective will be to seize and occupy Southern Mines. The armored brigade will then proceed to Yellow Mountain Pass. Supporting attacks - To minimize the time required to reach the Port of Utopia, one armored brigade from Fort Green will move north and take up a position within the forest to the west of the Port of Utopia. When the attack begins, the brigade will cross the border into UTOPIA and join a marine amphibious brigade for a combined assault on the port. Simultaneous airborne assault on Yellow Mountain Pass by one airborne brigade. Their objective will be to delay enemy advance through Yellow Mountain Pass until armored brigade arrives from Southern Mines.

5. Analysis of Relative Combat Power. According to latest intelligence, Country RED has the following forces tasked for operations in UTOPIA:

3 armored/mechanized brigades
1 airborne brigade
1 amphibious ready group
1 marine amphibious brigade
1 carrier task force
2 tactical fighter wings
1 JTF HQ
1 tactical air control system

The capability of enemy forces is presently comparable to our own. However, enemy plans for invasion of UTOPIA are unknown as are enemy plans for upgrading their joint task force.

6. NBC Warfare. We will not use nuclear, biological, or chemical weapons. Because we do not know enemy intentions, our forces must remain properly equipped and throughly trained for NBC defense.

7. Restrictions on Operations.

a. Close control by the NCA is necessary because of the danger of rapid escalation. Again, rapid and reliable communications are essential between the NCA and the JTF HQ.

b. Because of political considerations, we will not launch any strikes against forces located within the geographic boundaries of Country Yellow.

8. Pertinent Assumptions.

a. It is estimated that military action to ensure a continued supply of critical resource X will be necessary between two and six years in the future with six years being the more likely.

b. Country BLUE will remain our ally and continue to allow us to maintain combat forces there.

c. Country YELLOW will remain an ally of RED and RED will employ forces stationed in YELLOW to support their operations in UTOPIA.

9. Essential Elements of Information.

a. General:

(1) Determine if and when the enemy is planning to invade the Country of UTOPIA.

(2) Determine if the enemy plans to employ NBC weapons.

b. J1, Personnel

(1) The attitude of the civilian populace within the area of operations.

(2) The amount of food and medical supplies available in the area of operations for distribution to the civilian populace when we secure the area.

c. J3, Operations

(1) Detailed up-to-date enemy order of battle.

(2) Location of enemy JTF HQ.

d. J4, Logistics

(1) Cross-country trafficability studies for wheeled and tracked vehicles.

(2) Location of indigenous POL facilities in area of operations.

e. J6, Communications-Electronics

(1) Availability and nature of enemy electronic jamming capability.

(2) Enemy satellite survelIance capability which can detect the movement of our forces.

10. Request that each directorate prepare their staff estimate. Include your determination of which proposed course of action can best be supported from your standpoint. J6, also include your recommendation for the location of the JTF HQ.

COMBAT OUTCOME TABLE

Random Numbers

		1	2	3	4	5
		6	7	8	9	10
	-5	1 0 0 2 0 0	1 0 0 2 0 0	2 0 0 2 0 0	2 0 0 2 0 0	2 0 0 1 0 0
P		2 0 0 0 0 0	1 1 1 0 0 0	2 1 1 0 0 0	2 2 2 0 0 0	9 9 9 0 0 0
O	-4	1 0 0 3 1 0	1 0 0 3 0 0	2 0 0 1 2 0	2 0 0 1 1 0	2 0 0 1 0 0
I		2 0 0 1 0 0	2 1 0 1 0 0	1 1 1 0 0 0	2 1 2 0 0 0	3 2 2 0 0 0
N	-3	1 0 0 2 2 1	1 0 0 2 1 0	1 1 0 1 0 1	1 1 0 2 0 0	2 0 0 1 0 0
T		1 1 0 1 0 0	2 1 0 1 0 0	3 1 0 1 0 0	3 1 1 1 0 0	3 2 1 0 0 0
	-2	1 0 0 2 2 1	0 1 0 3 0 1	1 0 0 1 1 1	1 0 0 1 0 1	1 1 0 1 0 0
D		0 1 0 1 0 0	2 1 0 0 1 0	2 1 0 0 1 0	3 1 0 1 0 0	3 1 1 1 0 0
I	-1	0 1 0 3 1 1	1 0 0 3 1 1	2 0 0 3 1 0	2 0 0 2 1 0	1 0 0 1 0 0
F		0 0 0 0 0 0	2 0 0 1 0 0	2 1 0 1 0 0	2 1 0 0 0 0	2 1 1 0 0 0
F	0	1 0 0 3 1 2	1 0 0 3 2 1	2 0 0 2 1 1	1 0 0 2 0 1	2 0 0 2 0 0
E		1 0 0 1 0 0	0 0 0 0 0 0	1 0 0 0 0 0	2 0 0 0 0 0	1 1 1 0 0 0
R	1	1 0 0 3 2 1	0 1 0 3 2 1	1 0 0 2 1 1	2 0 0 2 1 1	1 0 0 0 1 0
E		2 0 0 2 0 0	1 0 0 1 0 0	0 0 0 0 0 0	1 0 0 0 0 0	2 1 0 1 0 0
N	2	1 0 0 2 2 2	1 0 0 3 2 1	1 0 0 3 1 1	1 0 0 2 2 1	1 0 0 1 1 0
C		1 0 0 0 1 0	2 0 0 0 1 0	1 1 0 0 1 0	1 0 0 1 0 0	1 0 1 1 0 0
E	3	0 0 0 4 2 2	0 0 0 2 2 2	1 0 0 3 2 1	1 0 0 3 2 1	1 0 0 1 1 1
		1 0 0 1 0 1	1 0 0 0 0 1	1 0 0 0 1 0	2 0 0 0 1 0	2 0 0 0 1 0
	4	0 0 0 9 9 9	0 0 0 3 2 2	0 0 0 3 2 2	0 0 0 2 2 2	0 0 0 1 2 1
		1 0 0 0 1 1	1 0 0 0 1 1	1 0 0 0 0 1	1 0 0 0 0 1	2 0 0 0 1 0

APPENDIX B

COMEL MAINTENANCE MANUAL

FIGURES

1. INTRODUCTION

The purpose of this manual is to document the software used in Communications Electronics War (COMEL) so that it can be modified easily. The program was written using modular design, frequent comments, and structured FORTRAN in an attempt to write code that could be read, understood, and modified by novice programmers. Further information can be found in the Users' Manual and the Thesis.

This manual is divided into four major sections to describe machine dependency, the main and control programs, the Acquisition Phase, and the Operations Phase.

2. HARDWARE/SOFTWARE DEPENDENCY

This section describes the characteristics of the program that make COMEL dependent on the specific computer and operating system for which it was designed.

COMEL was developed on a Digital Equipment Corporation VAX 11/780. The operating system used is VMS. (VAX stands for Virtual Address Extension and VMS stands for Virtual Memory System.) COMEL can be run on any other system that supports FORTRAN-77 and has some type of command file executive. Any type of terminal can be used to play COMEL.

Throughout the program, but primarily in the Operations Phase, random numbers are used. The VAX/VMS system function RAN (which calls the subroutine RANDOM) is used to generate the pseudo-random numbers. The function updates the seed, which is carried from module to module as a common variable.

FORTRAN 77 structures, such as the DO WHILE and the IF-THEN-ELSE-IF are used extensively, as is variable type character which allows easy structuring of the program and enhances its maintainability and readability. To modify the game to run on another verson of software, which does not have these features, would require a line-by-line review of the code to locate and modify these structures. The system functions FLOAT, IFIX, ATAN, and MIN are used but are also

availible on most FORTRAN compilers. The only other system unique function used in the actual COMEL FORTRAN modules is the time routine SECNDS (defined by the system as time in seconds since midnight).

COMEL can be run two ways. There is an extended version that runs via a control language (VAX/VMS command language). The other version is the same game run without the control language extension. The only difference between the two versions is that the extended COMEL takes care of game file preparation, modification, and exercise data saving (This process is explained in the Users' Manual and in Section 3.4 of this manual). This method was selected despite the machine dependency, since the efficiency of doing the file manipulation at the command level of the computer far exceeded the writing of the equivalent code in FORTRAN (ie, about a 500 line command language program instead of a 2000+ line FORTRAN program).

While not a machine dependency, one technique used to control the synchronization of the Umpire, Red, and Green terminals used in this war game, should be explained in this section. An important part of COMEL involves the timing of actions to be taken by the different players in the game. The Red or Green Player can only take actions during a specified part of the game (ie, for a given turn only so many minutes are allotted). When this time has expired, the player must wait until the Umpire (or control program) has

accomplished some tasks (budget planning, war execution, etc). Some control information also has to be passed to the players by the Umpire (current game status, war status, end of game commands, etc). This is done through a synchronization routine.

The synchronization is accomplished via a common direct access file. Three flags control the flow of control, a controller flag (ictl), Red Player flag (ired) and Green Player flag (igrn). These flags are set to zero or one depending on the action to be taken. When the Umpire wants to hold the players , a zero is written to ired and igrn. The players' game will be stopped until the Umpire sets ired and igrn to one. If ictl is equal to 9, the Acquisition or Operation Phase will be stopped. Initially, ictl is equal to one and ired and igrn are set to zero. Red Player sets ired to one and Green Player sets igrn to one when each logs on. In the same way, control is halted at the end of each turn by issuing the appropriate flag.

3. MAIN PROGRAM AND CONTROL MODULES

The control program sets up the files used in COMEL. It is written in the VAX/VMS command file language. The control modules are started by the control program. These control modules are short FORTRAN programs that call the appropriate phase of COMEL.

3.1 PROGRAMMING STYLE

The command file program is written to manipulate the game files. The style of programming is limited to placing the commands in the correct order for execution. The FORTRAN modules called control the execution phase entered in COMEL.

3.2 ERROR CHECKING

The error checking performed is limited to testing for correct menu input and trapping error conditions to prohibit the Umpire or player from being thrown out of the program. Instead, the question will be repeated. The FORTRAN control module will only allow menu selections to be entered.

3.3 STRUCTURE OF THE CONTROL PHASE

The control phase of the program consists of setting up the files, running the program, entering the correct phase, and saving the files on exit from the game.

3.4 CONTROL MODULES (ACQUISITION AND OPERATIONS)

COMEL CONTROL PROGRAM (COMMAND FILE)

File: COMEL.COM

Purpose and Method:

A collection of command language routines used by the Umpire to manipulate the game files (save, restore, delete) and run COMEL.

The main menu of the command file is displayed on the terminal and user input is requested. The action requested is carried out via a GOTO to a command module written to carry out the Delete, Save, or Restore.

Two error routines are provided to prevent the accidental destruction of files. One is to prevent the program from failing due to an error in the command file (ie, copying a non-existant file). The second error protection is to return to the main menu if the Umpire/Player tries to exit COMEL via a CTRL-Y.

Subprograms Called:

UMPIRE.FOR (Main Program)

MAIN PROGRAM UMPIRE

File: UMPIRE.FOR

Purpose and Method:

This is the control program the Umpire uses to choose to play the Acquisition, Operation or both phases of COMEL.

The menu is displayed and, depending on the option selected, control is passed to the called routine. When the program is exited, control is returned to the command program.

Major Variables:

fini - logical; controls exit from this program

Subprograms Called:

Subroutine GAMINF
Subroutine ACQCTL
Subroutine OPNCTL

Entries:

@COMEL

SUBROUTINE PLAYER

File: PLAYER.FOR

Purpose and Method:

This is the control program for the player. The player is identified as Red or Green. The Acquisition, Operation or both phases of play is then selected.

Major Variables:

fini - logical; controls end of program

iredpl - integer; flag indicating a Red Player

igrnpl - integer; flag indicating a Green Player

Subprograms Called:

Subroutine PLYINF
Subroutine PAGE
Subroutine REDACQ/GRNACQ
Subroutine REDOPS/GRNOPS

Entries:

@PLAYER

SUBROUTINE ACQCTL

File: ACQCTL.FOR

Purpose and Method:

This module provides timing and sequencing for the Acquisition Phase of the game.

Output Acquisition game header to the Umpire and call input routine for system data. The Umpire enters the length of coming turn and then is provided the budget history. Set synchronization file to wait for Red and Green Player. Update stop time and then let Red and Green Players start turn. Loop through a delay routine until both players are done or until time runs out. The players then enter a waiting stage. The Umpire enters the intelligence update phase. The next turn starts unless war begins in which case the Acquisition Phase ends.

Major Variables:

durmin - real; time in minutes of current turn

ictl,igrn,ired - integer; action completion flags

hhmmss - character * 8; time of day

s,it,r,q - real; dummy variables

pwar - real; the current probablity that war will occur

x - real: contains the result of random variable function

Common Variables Changed:

iplayr
iseed
stopat

Subprograms Called:

Subroutine SYSEQP	Subroutine PAGE
Subroutine BGTHST	Subroutine TIME
Subroutine WRITIT	Subroutine READIT
Subroutine DELAY	Subroutine TATTLE

Entries:

Main Program UMPIRE.FOR

SUBROUTINE PAGE

File: PAGE.FOR

Purpose and Method:

This routine clears the terminal display by writing 24 blank lines.

Entries:

General Utility

SUBROUTINE READIT

File: READIT.FOR

Purpose and Method:

This routine opens and reads the synchronization file necessary for control of the game. The budget and turn is passed to the players.

Parameters passed:

```
ictl    igrn    ired    stopat
iturn   redbgt  grnbgt
```

Subprograms Called:

Subroutine DELAY

Data Files Accessed and File Name:

50 - Synchronization File SYNCH.DAT

Entries:

General Utility

<u>SUBROUTINE WRITIT</u>

File: WRITIT.FOR

Purpose and Method:

This routine opens and writes to the synchronization file items necessary for control of the game.

Parameters Passed:

```
ictl    igrn    ired    stopat
iturn   redbgt  grnbgt
```

Subprogram Called:

Subroutine DELAY

Data Files Accessed and File Name:

50 - Synchronization File SYNCH.DAT

Entries:

General Utility

SUBROUTINE DELAY

File: DELAY.FOR

Purpose and Method:

This routine is used whenever a delay in execution is desired. The delay is the parameter passed, in seconds, to the program.

Parameters passed:

t1 - real; time delay routine entered

Major Variables:

delta - real; The difference between time entered delay and current time.

a - real; A variable entered just to delay.

Entries:

General Utility

SUBROUTINE OPNCTL ()

File: UMPFILE.FOR

Purpose and Method:

This module provides timing and sequencing for the Operations Phase of the game.

Output Operations game header. Check whether starting a new game; get seed and call input subroutine or read blackboards. Display unit positions to set up map. Loop through turns. Input turn length and rules of engagement. If it is not the first turn, output intelligence. Output blackboards. Wait for players to finish turn, checking periodically for messages or end of

time limit. When time is up or both players are finished, continue with movement, combat, and end of war decision.

Major Variables:

hhmmss - character*8; time

first - integer; rules of engagement

ictl,igrn,ired,it,ishr,ismn - integers; action completion flags

durmin - real; length of turn in minutes

dummy,s,stemp - real; dummy variables

stopat - real; scheduled end of turn

over - logical; true if game is to end

Subprograms Called:

Subroutine PAGE	Subroutine RULES
Subroutine DELAY	Subroutine OPINTEL
Subroutine TIME	Subroutine INPUT
Subroutine WRITIT	Subroutine RPOSIT/GPOSIT
Subroutine READIT	Subroutine RMOVE/GMOVE
Subroutine RMSG/GMSG	Subroutine DICTION
Subroutine SYSOUT	Subroutine COMBAT
Subroutine SYSBRD	Subroutine ENDWAR
Subroutine REDOUT/GRNOUT	Subroutine REDBRD/GRNBRD

Entries:

Main program UMPIRE.FOR

<u>SUBROUTINE REDOPS/GRNOPS</u> ()

File: RED.FOR/GREEN.FOR

Purpose and Method:

This module controls the timing and sequence of the routines for the Red or Green Player.

Output Operations Phase header. Wait until start is indicated by Umpire, checking periodically for messages. On the first turn call module to assign equipment to units. Call turn module; return to waiting.

Major Variables:

ictl, ic, ired,igrn - integers; control flags

stopat - real;time for scheduled end of turn

dummy,st - real; dummy variables

hhmmss - real;present time

Subprograms Called:

Subroutine PAGE	Subroutine RMSG/GMSG
Subroutine TIME	Subroutine RCOMM1/GCOMM1
Subroutine READIT	Subroutine RTURN/GTURN
Subroutine WRITIT	Subroutine DELAY

Entries:

Main program PLAYER.FOR

SUBROUTINE RLISTEN/GLISTEN (QUEST,ANS)

File: GENERAL.FOR

Purpose and Method:

This module allows an active terminal to listen for and read the answer to a message previously sent to another terminal. The exchange of messages is between the Umpire and a player.

Parameters:

quest - integer; flag indicating whether answer is expected to the question

ans - character*1; answer, blank returned if no answer is expected

Subprograms Called:

Subroutine DELAY

Entries:

General Utility

<u>SUBROUTINE RMSG/GMSG</u> ()

File: GENERAL.FOR

Purpose and Method:

This module allows a terminal in waiting status to receive and answer messages from another terminal. The exchange of messages is between a player and the Umpire.

Major Variables:

flag - integer; flag showing an answer is expected

record - character*80; text of message

ans - character*1; answer

Subprograms Called:

Subroutine DELAY
Subroutine PAGE

Entries:

Subroutine OPNCTL
Subroutine REDOPS/GRNOPS

<u>SUBROUTINE OPEN</u> (NUM)

File: GENERAL.FOR

Purpose and Method:

This module opens file 'num', making an error check to see if the file is empty.

Parameter:

num - integer- number of the device to be opened

Entries:

General Utility

4. THE ACQUISITION PHASE

The Acquisition Phase selects the electronic equipment to be used by the units in the Operations Phase of the game. This phase is an exercise of planning, time management, budgeting, and forecasting.

4.1 PROGRAMMING STYLE

All modules in the Acquisition Phase are written in a top down and structured format for ease of maintenance and program extension. That is, program control flows downward and GOTO statements are limited to the extent possible. Each module takes care of one specific action (or related actions). Indentation is designed to enhance readability of the program.

FORTRAN 77 unique constructs were used to simplify the programs and increase maintainability and reliability. However, standard FORTRAN is used as much as possible to enhance transportability and conversion to different computer systems. In the Acquisition modules, the 'DO WHILE...END DO' constructs are used only to control exit from a module or a file. The 'IF...THEN...ELSE' construct is only used as an 'IF...THEN' with no nested 'IF' statements within the construct. Programming in this manner

will simplify conversion to standard FORTRAN, should it be necessary. It will also simplify a novice programmer's ability to understand the modules logic.

4.2 ERROR CHECKING

There are three categories of errors that may occur in any program. The first type of error is entering extraneous characters or commands. The second type of error is entering values out of range. The last type is system errors.

Extraneous characters entered in the program can be controlled through the 'ERR' and 'END' options of the 'READ' statement. Extraneous values (other than numeric) will force an error condition if the system expects real or integer data. All READ statements in the Acquisition Phase have error handlers that prevent abnormal termination due to read errors.

Entry range acceptability checks are performed in the Acquisition Phase to prevent logic and system errors.

Occasionally an unforeseen system error may occur due to hardware failure, power outages, computer systems software failure, etc. Since all data used in Acquisition is written to files between game turns, a system error will result in loss of only the current game step data. Also, the COMEL command file has an error routine built in that will bring

the program back to the COMEL or PLAYER main menu (even if a CONTROL-Y is entered) unless the system crashes.

4.3 STRUCTURE OF THE ACQUISITION PHASE

The Acquisition Phase and modules used are described in the following sections.

4.3.1 Game Sequence

The two players and the Umpire are operating in a timed sequence controlled by the modules described in Section 3. The Acquisition Phase is repeated until the random number selected exceeds the probability of war and war does occur (unless Umpire starts war earlier or overides the start of war).

The sequence of play is:

a. The Umpire enters the length of turn in minutes.

b. The Umpire gives Red/Green Players their budget.

c. Control is passed to the players.

d. The players have a timed turn in which they can procure equipment and move this equipment through the acquisition life cycle, or scrap the equipment.

e. Control is returned to the Umpire where the intelligence update program is entered and the Umpire reviews player status so intelligence can be updated.

f. The program then determines if war or the next turn occurs.

4.3.2 Common Variables

There are three classes of common variables used in the Acquisition Phase; system data, electronic equipment selected and control parameters.

System data is read into the common each game turn. However, it does not change during the war game. The file is read into common each game turn for recovery purposes in case of system error. System data contains all system parameters used for Acquisition, such as technical capablities, cost information, and number of each system available.

Electronic equipment data is dynamic and will change each game turn. The array of equipment data contains electronic equipment selected by Red/Green and the state of the equipment (R+D, AR+D, M+D, O+M, etc). A reference in this file points to the location of the electronic equipment information in the system data array (RITEM/GITEM). This array is also saved to a file from the common area at the end of each game turn and read from a file into common area at the beginning of the game turn.

Parameters used in the program are kept in the named common called /PARAMS/. The data in this common is not kept in a file between game turns. It remains in memory the entire game. It is used for control of program execution during the play of the game.

4.3.3 Interfaces

Interfaces between the Umpire and player are via files. Synchronization is accomplished by the data contained in 'SYNCH.DAT'. This file contains controls necessary for timing, turn, budget and length of turn. The equipment selected is passed to the Umpire via the 'REQUIP/GEQUIP.DAT' file. Intelligence is passed via 'RINTEL/GINTEL.DAT' file. More budget information is found in the 'BGTHST.DAT' file.

4.4 MODIFICATIONS

More Acquisition routines may be added to COMEL or modifications made to existing routines. Additional decision analysis aids or other actions may be desired. Modules can easily be added to the Acquisition Phase by adding another 'MENU' item, an 'IF' statement to select this item, and the subroutine 'module' within the routine. Modifications to the program should be easy, since the program is structured and does not rely heavily on GOTO's. However, care must be exercised if the control program is modified due to the synchronization routines. Examples of synchronization routines are ; WRITIT, READIT, ACQCTL, REDACQ, GRNACQ, ITURN, STOPAT, ICTL, IRED, and IGRN.

4.5 COMMON VARIABLES (ACQUISITION PHASE)

Acquisition uses three types of common variables; information on systems available for purchase, arrays of electronic equipment that have been purchased, and parameters that are used to control the game play. These common variables are identified below.

<u>/SYSTEM/</u>

system(100) - character * 8; equipment nomenclature

rsystm(200) - character * 8; selected red equipment nomenclature

gsystm(200) - character * 8; selected green equipment nomenclature

etype (100) - character * 5; classifies each system by type

eqpdat - character * 20; holds equipment data file name

sysdat - character * 20; holds system data file name

<u>/SYSACQ/</u>

noa(100) - integer; number of end items of each kind available

rdcost(100) - integer; cost in $M for R+D of system

rdtime(100) - integer; time in years required for R+D

ardcst(100) - integer; cost for accelerated R+D

ardtim(100) - integer; time for accelerated R+D

mdcost(100) - integer; cost for manufactoring and deployment

mdtime(100) - integer; time in years for M+D

nomcst(100) - integer; cost of normal operating and maintenance

romcst(100) - integer; cost of O+M at reduced readiness

/SYSOPS/

mob (100) - integer; mobility in hexes per turn

crng (100) - integer; communications range in hexes; beamwidth of satellites

crngs (100) - integer; for HF equipment, skywave range

sec (100) - integer; security factor; ability to resist jamming and intrusion

rel (100) - real; reliability

rels (100) - real; reliability of HF equipment in skywave operation

flex (100) - real; flexibility

opt (100) - real; optimization

c3e (100) - real; C3 effectiveness

c3es (100) - real; C3 effectiveness of HF in skywave operation

ewf (100) - integer; electronic warfare effectiveness; ability of EW equipment to overcome the security factor of communications equipment

ecm (100) - real; effectiveness of jamming

esm (100) - integer; ability to detect emmissions

beams (100) - integer; for satellites, the number of beams

/REDEQP/

ritem (200) - integer; points to the location of the system in the system data arrays

reff (200) - real; effectiveness of the selected system; equal to 1 if system is fully effective, .5 if system is partially effective (reduced operation status), 0 if not yet placed into operation

ryrbgt(200) - integer; the year a system was placed in R+D or M+D

ryrrdy(200) - integer; the year a system will finish R+D or M+D

irdcst(200) - integer; the cost of the current stage of acquisition

irbuy (200) - integer; a flag indicating that a system is finished M+D

iracc (200) - integer; a flag indicating that a system is in accelerated R+D

irexp (200) - integer; a flag indicating that a system is in normal R+D

irred (200) - integer; a flag indicating that a system is in reduced operation

irmnfd(200) - integer; a flag indicating that a system is being manufactored for deployment

irfrd (200) - integer; a flag indicating that a system is finished R+D

/GRNEQP/

ritem (200) - integer; points to the location of the system in the system data arrays

geff (200) - real; effectiveness of the selected system; equal to 1 if system is fully effective, .5 if system is partially effective (reduced operation status), 0 if not yet placed into operation

gyrbgt(200) - integer; the year a system was placed in R+D or M+D

gyrrdy(200) - integer; the year a system will finish R+D or M+D

igrcst(200) - integer; the cost of the current stage of acquisition

igbuy (200) - integer; a flag indicating that a system is finished M+D

igacc (200) - integer; a flag indicating that a system is in accelerated R+D

igexp (200) - integer; a flag indicating that a system is in normal R+D

igred (200) - integer; a flag indicating that a system is in reduced operation

igmnfd(200) - integer; a flag indicating that a system is being manufactored for deployment

igfrd (200) - integer; a flag indicating that a system is finished R+D

/PARAM/

iturn - integer; the current acquisition year

stopat - real; the time that the turn will be over (seconds since midnight)

redbgt - real; the current years budget for red

grnbgt - real; the current years budget for green

rbgusd - real; the Red Players budget minus amount spent

gbgusd - real; the Green Players budget minus amount spent

rbgreq - real; the Red Players budget request for next year

gbgreq - real; the Green Players budget request for next year

nbrsys - integer; the number of systems in the system file

nbreqp - integer; used to hold the number of equipment in red or green equipment file

iueqp - integer; holds the unit number for various files during play

iplayr - integer; holds the player id (1 = green, 2 = red) used to communicate between routines

inrd - integer; number of red equipment

igen - integer;number of green equipment

iseed - integer; random number seed used

4.6 THE ACQUISITION MODULES

SUBROUTINE GAMINF/PLYINF

File: GAMINF.FOR/PLYINF.FOR

Purpose and Method:

This routine pages through a game documentation file to supply game information to the Umpire/Player.

The routine opens the information file and reads it to find how many records are contained in the file. The number of pages it can display is computed (records/15). The Player/Umpire can page through the file by entering the desired page number.

Major Variables:

mesg - character * 80; information file record

endfil - logical; used to test for end of file

nlines - interger; number of lines currently displayed

itemp - integer; temporily used for location of page

inmb - integer; page selected for viewing

ifrom - integer; last record read

Subprograms Called:

Subroutine PAGE
Subroutine DELAY

Data Files Accessed and Name:

60 - Game Information File GAMINF.FOR
65 - Player Information File PLYINF.FOR

Entries:
Main program PLAYER.FOR

Main program UMPIRE.FOR

SUBROUTINE SYSEQP

File: SYSEQP.FOR

Purpose and Method:

This routine opens and reads the data files necessary for the Acquisitions Phase.

Open and read files for system information and Red equipment or Green equipment files. Red or Green equipment file is updated depending on the value of IPLAYR (1=green, 2=red) or IUEQP (16=green,15=red).

Common Variables Changed:

sysdat	eqpdat	system	etype
rsystm	gsystm	noa	rdcost
rdtime	ardcst	ardtim	mdcost
mdtime	nomcst	romcst	mob
crng	crngs	sec	rel
rels	flex	opt	c3e
c3es	ewf	ecm	esm
beams	ritem	reff	ryrbgt
ryrrdy	irdcst	irbuy	iracc
irexp	irred	irmnfd	irfrd
gitem	geff	gyrbgt	gyrrdy
igrcst	igbuy	igacc	igexp
igred	igmnfd	igfrd	

Data Files Accessed and File Name:

14	- System list	SYSTEM.DAT
15	- Red equipment list	REQUIP.DAT
16	- Green equipment list	GEQUIP.DAT

Entries:
Subroutine TATTLE

SUBROUTINE BGTHST

File: BGTHST.FOR

Purpose and Method:

This routine allows the Umpire to enter the Red and Green Players' budgets.

The budget file is opened and checked for data. Each record constitutes one year. If no data records exist, then ITURN is set to one. If there are data records, they are displayed for the Umpire's use. The Umpire then gives the Red and Green Players their budget for that year.

Major Variables:

lsturn - integer; the current turn minus one

Common Variables Changed:

redbgt grnbgt

Common Variables Referenced but not changed:

iturn
rbgusd
gbgusd
rbgreq
gbgreq

Subroutines Called:

Subroutine DELAY
Subroutine PAGE

Data Files Accessed and File Name:

99 - Budget history BGTHST.DAT

Entries:

Subroutine ACQCTL

SUBROUTINE TATTLE

File: TATTLE.FOR

Purpose and Method:

TATTLE is used by the Umpire to read the mail files and to read the status of Red/Greer Acquisition Phase.

TATTLE is menu driven. The Umpire can select Red/Green game summary and can read the Red/Green mail files. It allows the Umpire to proccess Red/Green intelligence requests. The Umpire then can respond by updating Red/Green answer file.

Major variables

fini - logical; used to test whether user would like to exit intel.

Endfil - logical; used to check end of file status

rtyp - Character * 2; Record type in the Red/Green Intelligence File.

irqyr - integer; The turn intelligence was requested.

ignr - integer; A flag indicating if player would like a general intel brief.

isr - integer; a flag indicating if player would like a specific intel brief.

insyst - character * 8; The system that player would like intel info on

ist - integer; not used

infrd - integer; used by player to request if system is in R+D

inbuy - integer; flag used by player to request if a system will be bought

inamt - integer; flag to request how many of a system will be bought

indte - integer; flag to request when the system will be ready.

msg - character * 80; This is the message that the controller received from the player receives as an answer.

Common Variables Changed:

iplayr
iueqp
eqpdat
stopat

Subprograms Called:

Subroutine SYSEQP
subroutine SYSTMS
subroutine DELAY
subroutine PAGE

Data Files Accessed and File Name:

25	Red Intelligence File	RINTEL.DAT
20	Green Intelligence File	GINTEL.DAT

Entries:

Subroutine ACQCTL

SUBROUTINE REDACQ/GRNACQ

Files: REDACQ.FOR/GRNACQ.FOR

Purpose and Method:

Provides the sequencing for the players during the Acquisition Phase of the game.

Output Acquisiton game header then a message if a player is waiting for the other player to LOGIN. Begin a game loop. Load the system data and player equipment files. Set a logged in flag. Delay at this point until other player logs into the game. Obtain budget and stop time. Call the main Acquisition module. After acquisition, set a flag and enter a hold loop. When the Umpire is finished, a flag is set by the Umpire so the next turn can start.

Major Variables Changed:

hhmmss - character *8: time of day

ic,ib,it - integer: dummy

r,s,re,ge,st - real: dummy

Common Variables Changed:

iplayr	sysdat	eqpdat	iueqp
igrn	ired		

Common variables Referenced but Not Changed:

ictl
stopat
iturn
redbgt
grnbgt

Subprograms Called:

Subroutine PAGE	Subroutine WRITIT
Subroutine TIME	Subroutine DELAY
Subroutine READIT	Subroutine ACQUIS

Entries:

MAIN PROGRAM PLAYER

SUBROUTINE ACQUIS

File: ACQUIS.FOR

Purpose and Method

This is the main program that enables players to acquire electronic equipment. It displays the main menu options to allow the player to carry out the acquisition strategy.

The control of system information and acquisition is via menu. The players options are listed. At the top, budget and time information is displayed. The current time is checked against the STOPAT time prior to the execution of a subroutine. If stop time is exceeded, or the exit option is selected, the equipment data is saved to a file and control passed to REDOPS/GRNOPS. If budget has been exceeded, a warning is displayed. After, the above checks are made, the selected option is executed. Upon exit of this routine, an end of turn message is displayed.

Major Variables:

bspent -real; the amount of the origional budget already spent.

itime - integer; the time, in minutes, remaining for a decision

Common variables Changed:

gbgusd
rbgusd

Common Variables Referenced but Not Changed:

grnbgt
redbgt
iplayr
stopat
iturn

Subprograms Called:

Subroutine UPDBGT	Subroutine SYSTMS
Subroutine PAGE	Subroutine INTEL
Subroutine SAVEQP	Subroutine BGTAR
Subroutine SHOP	Subroutine PROCUR

Entries:

Subroutine REDACQ/GRNACQ

SUBROUTINE UPDBGT

File: UPDBGT.FOR

Purpose and Method:

This program inspects the player's equipment file and computes the current funds obligated from the given budget and subtracts that amount from the player's funds. The acquisition status of the equipment (R+D, AR+D, M+D) is also checked and updated if necessary.

The budget used by Red/Green Player is set to zero. Each piece of equipment (RECORD) is checked for flag set and year ready. The appropriate money is added to the budget used for those systems in active M+D, R+D, AR+D and normal O+M and reduced O+M. If a system is in M+D, R+D, AR+D and the year ready field of the record is equal to the current turn, then the M+D flag is set to zero and the buy flag is set to one. If the AR+D or R+D flag is set to zero then the finished R+D flag is set to one. At the end of the appropriate equipment file, the program returns control to ACQUIS.

Common Variables Changed:

```
rbgusd  abgusd  igexp   irexp
igfrd   irfrd   igmnfd  irmnfd
igbuy   irbuy
```

Common Variables Referenced but Not Changed:

```
iplayr  iturn   gyrrdy  ryrrdy
rdcost  gitem   ritem   ardcst
mdcost  nomcst  romcst  geff
reff
```

Entries:

Subroutine ACQUIS

SUBROUTINE SAVEQP

File: SAVEQP.FOR

Purpose and Method:

SAVEQP will take the current contents of the Red/Green equipment arrays and write them to the equipment files. The budget file is also updated with the budget used by Red/Green the past acquisition year.

The Red/Green equipment file is opened. The contents of the Arrays are written to the opened file. If RSYSTM/GSYSTM is blank, the record is not written. If IGBUY/IRBUY is equal to one, then the system is not written. The equipment file is closed, and the budget file is opened. The budget record for the turn is updated with the budget used by Red/Green. The budget file is closed and the program returns control to ACQUIS.

Major Variables:

rbg,gbg,rusd,gusd,rreq,greq - real; dummy

Common variables Changed:

gsystm	rsystm	igbuy	irbuy
gitem	ritem	geff	reff
gyrbgt	ryrbgt	gyrrdy	ryrrdy
igrcst	irdcst	igacc	iracc
igexp	irexp	igred	irred
igmnfd	irmnfd	igfrd	irfrd
gbgusd	rbgusd		

Common Variables Referenced but Not Changed:

iueqp
eqpdat

iplayr
nbreqp

Subprograms Called:

Subroutine DELAY

Subroutine ERASE

Data Files Accessed and File Name:

15	- Red Equipment List	REQUIP.DAT
16	- Green Equipment List	GEQUIP.DAT
99	- Budget History list	BGTHST.DAT

Entries:

Subroutine ACQUIS

SUBROUTINE ERASE

File: ERASE.FOR

Purpose and Method:

Erase is used to initialize the equipment and system arrays through the use of Data statements with either zero or blanks. This is done to clean the common areas out between game turns so extraneous information is erased.

Common Variables Changed:

rel	rels	flex	opt
c3e	c3es	ecm	geff
reff	rbgreq	gbgreq	stopat
redbgt	grnbgt	rbgusd	gbgusd
noa	rdcost	rdtime	ardtim
mdcost	mdtime	nomcst	ardcst
romcst	mob	crng	crngs
sec	ewf	esm	beams
ritem	ryrbgt	ryrrdy	irdcst
gitem	gyrbgt	gyrrdy	igrcst
iturn	nbrsys	nbreqp	iueqp
intr	intg	inrd	igen

Entries:

Subroutine SAVEQP

SUBROUTINE SHOP

File: SHOP.FOR

Purpose and Method:

Shop is used to load the Red/Green Players equipment arrays with systems from the system data array. These systems are candidates for procurement and all flags are set to zero. No more than the allotted amount of each system type (NOA) can be placed in the equipment arrays.

The terminal display is cleared. Next, the entire list of systems available (along with equipment type and reference number) is displayed. The player will select a system via the menu number for possible inclusion in the equipment arrays. If the player has not run out of time, continue. Next, ask the player if more system information is desired, else, call a routine to add the system to file.

Major Variables:

hhmmss - character * 8; time of day

idectm - integer; time in minutes left to make decision

npage - integer; a value used to allign the columns on the output display

i1,i2,i3,i4 - integer; a value used with npage for terminal display

itmnbr - integer; a user input to select a system in the display

Common Variables Referenced but Not Changed:

stopat
nbrsys
system
etype

Subprograms Called:

Subroutine PAGE
Subroutine TIME
Subroutine SYSINF
Subroutine SYSOPT

Entries:

Subroutine ACQUIS

SUBROUTINE SYSINF

File: SYSINF.FOR

Purpose and Method:

SYSINF provides system information on the particular system selected by SHOP.

The display is cleared. The player is given the system name and equipment type and asked whether more information is desired. If yes, a narrative description is given on the equipment type from a file with this data in it. Next, technical information is obtained from the system array if desired. Then , cost information is displayed if requested. The program returns control to the caller.

Parameters

itm - integer; index to system in the system file

Major Variables:

fini - logical; checks for end of file

equip - character * 5; equipment type read from system information file

descr - character * 74; Narrative description line from system info file

Common Variables Referenced but Not Changed:

```
system   etype    mob      rel
opt      ecm      sec      rels
flex     esm      crng     c3e
beams    ewf      crngs    c3es
noa      rdcost   rdtime   ardcst
ardtim   mdcost   mdtime   nomcst
romcst
```

Data Files Accessed and File Name:

55 - System Information   SYSINF.DAT

Entries:

Subroutine SHOP

SUBROUTINE SYSOPT

File: SYSOPT.FOR

Purpose and Methods:

This routine enables the player to add the system selected in SHOP to the equipment file.

The Red/Green Player is asked to enter how many of the selected system desired. First the Red/Green equipment arrays are checked for the number of that system already in the array. The player is then told how many systems of that type are in the file and the maximum number permitted. The number the user entered is reiterated. The program checks whether the maximum will be exceeded with the additional systems selected. The program then adds the systems to the equipment file (up to the maximum) and displays success or qualifies the message with the actual amount added. At this point, only the system name and location in the system array is added to the equipment arrays. The other values are set

to zero. The number of equipment is kept in common. The program then returns control to SHOP.

Major Variables:

nsyst - integer; number of that system you wish to add

isys - integer; number of that system already in file.

nbuy - integer; the difference between NOA and ISYS if less than NSYST, else equal to nsyst

Common Variables Changed:

```
gsystm  gitem   geff    gyrbgt
gyrrdy  igrcst  igbuy   igacc
igexp   igred   igmnfd  igfrd
rsystm  ritem   reff    ryrbgt
ryrrdy  irdcst  irbuy   iracc
irexp   irred   irmnfd  irfrd
npreqp
```

Common Variables Referenced but Not Changed:

```
system   iplayr
noa
```

Subprograms Called:

Subroutine PAGE

Entries:
Subroutine SHOP

SUBROUTINE SYSTMS

File: SYSTMS.FOR

Purpose and Method:

SYSTMS is used to summarize the current state of the equipment files for PLAYER/UMPIRE information.

Decision time left and budget are displayed along with a menu of options available for selection. If decision time expires, or, the Player/Umpire decides to exit, control is returned to the calling program. Next, totals are set to zero and the equipment array is analyzed based on flags set denoting the state of the systems. Totals are computed. Depending on the option selected in the main menu, summaries are displayed on the state of the array.

Major Variables:

fini - logical; used to control end of routine

budget - real; Red/Green budget

bgtlft - real; money left player

hhmmss - character * 8; time of day

itime - integer; decision time left

nrda - integer; number systems in accelerated R+D

nrdn - integer; number systems in normal R+D

nmnd - integer; number systems in M+D

ndeon - integer; number systems normally deployed

nomr - integer; number systems in reduced O+M

nbuy - integer; number systems ready to buy

nfrd - integer; number systems finished R+D

nlines - integer; number of lines displayed on screen

ntot - integer ; total of nrda, nrdn, nmnd, ndeon, nomr, nbuy, nfrd

Common Variables Referenced but Not Changed:

grnbgt	gbgusd	redbgt	rbgusd
stopat	iturn	nbreqp	iplayr
geff	reff	igmnfd	irmnfd

igexp   irexp   igacc   iracc
igbuy   irbuy   igfrd   irfrd
gsystm   rsystm   gyrrdy   ryrrdy
mdtime

Subprograms Called

Subroutine PAGE
Subroutine TIME

Entries:

Subroutine ACQUIS

Subroutine TATTLE

SUBROUTINE INTEL

File: INTEL.FOR

Purpose and Method:

This module enables the player to read the intelligence file containing either information requested or messages from the Umpire.

The Red/Green intel file is opened. The program loops through the file looking for 'A' record type. The year of this record is stored. Upon the end of file, the program displays a menu with a year to select range from the first year recorded to the last year recorded. No years will be listed if there is not any intel data. The player then selects a year from the menu. The file is rewound and the program then loops through the file again printing the selected records.

Major Variables:

iunit - integer; unit number of Green/Red intel file

ifile - character * 20; file name of Green/Red intel file

inty - integer; an array holding the selected intel years

itmpyr - integer; a temporary hold area for the year

fini - logical; a flag used to control end of routine

endfil - logical; a flag used to test for end of file

iyrfrs - integer; first year found in intel file

iyrlst - integer; last year found in intel file.

rtyp - character * 2; record type in intel file (A = answer)

irqyr - integer; year of request

msg - character * 80 ; message from Umpire

itime - integer; decision time left

inpick - integer; intel year player selects

nlines - integer; number of lines displayed on terminal

Common Variables Referenced but Not Changed:

iplayr stopat
iturn

Subprograms Called:

Subroutine DELAY
subroutine PAGE
subroutine TIME

Data Files Accessed and File Name:

20 - Green Intelligence Data GINTEL.DAT
25 - Red Intelligence Data RINTEL.DAT

Entries:

Subroutine ACQUIS

SUBROUTINE BGTAR

File: BGTAR.FOR

Purpose and Methods:

This program shows the player a breakdown of current budget obligations (those systems where money has been, or must be spent) and projects those obligations four years into the future. The player is also able to submit a budget request for next year.

The arrays for the display are initialized. Then each flag of the player's equipment array is checked for the status of that system. If money has been required, the appropriate array is updated (ie, number of systems in that stage and money obligated for that stage). A projection is then made for the current state of that system and for four years in the future by sequencing through the acquisition process and recording the money obligated for each of the systems five year life. A message explaining the procedure is displayed. The graph is then written on the terminal. Finally, the Red/Green Player is asked whether a budget request is to be submitted for the next year. If yes, the budget file is opened and the request entered.

Major Variables:

inrdn(5) - integer; number of systems in normal R+D for year I

inrdc(5) - integer; cost of systems in normal R+D for year I

iardn(5) - integer; number of systems in advanced R+D for year I

iardc(5) - integer; cost of systems in advanced R+D for year I

ismdn(5) - integer; number of systems in M+D for year I

ismdc(5) - integer; cost of systems in M+D for year I

iromn(5) - integer; number of systems in reduced O+M for year I

iromc(5) - integer; cost of sysems in reduced O+M for year I

inomn(5) - integer; number of systems in normal O+M for year I

inomc(5) - integer; cost of systems in normal O+M for year I

itotn(5) - integer; total number of systems for year I

itotc(5) - integer; total cost of systems for year I

numb - integer; used to conrol flow through cost projection

istrt - integer; for a given state, the year that the next state begins

idone - integer; for a given state, the year that the next state ends

rbgt,gbgt,rb,gb,yr,gr - real; dummy variables

Common Variables Changed:

rbgreq
gbgreq

Common Variables Referenced but Not Changed:

iplayr	nbreqp	geff	reff
igexp	irexp	iturn	gyrrdy
ryrrdy	mdtime	gitem	ritem
rdcost	ardcst	igacc	iracc
nomcst	mdcost	igmnfd	irmnfd

Subprograms Called:

Subroutine PAGE

Subroutine DELAY

Data Files Accessed and File Name:

99 - Budget History File BGTHST.DAT

Entries:

Subroutine ACQUIS

SUBROUTINE PRTSTS

File: PRTSTS.FOR

Purpose and Method:

PRTSTS prints the equipment lists of the Red/Green Player between each turn.

Common Variables Referenced but not changed:

nbreqp	iplayr	geff	reff
igmnfd	irmnfd	igexp	irexp
igacc	iracc	igbuy	irbuy
igfrd	irfrd	gsystm	rsystm
gyrrdy	ryrrdy	mdtime	

Data files Accessed and File Name:

70 - Green equipment print list EQPGRN.DAT
75 - Red equipment print list EQPRED.DAT

SUBROUTINE PROCUR

File: PROCUR.FOR

Purpose and Method:

PROCUR controls the procurement and acquisition phases of the systems in the equipment array. Intelligence can be purchased and a decision analysis made.

The program displays a menu with the options available for the Red/Green Player.

Major Variables:

fini - logical; used to control exit from subroutine

budget - real; red/green current budget

bgtlft - real; red/green remaining budget

itime - integer; decision time left

Common Variables Referenced but Not Changed:

iplayr grnbgt redbgt
stopat iturn

Subprograms Called:

Subroutine PAGE
Subroutine DECISN
Subroutine BUYSYS
Subroutine SCRAP
Subroutine RDACCL
Subroutine RDEXPN
Subroutine OMRED
Subroutine PINTEL
Subroutine MDEPLY

Entries:

Subroutine ACQUIS

SUBROUTINE DECISN

File: DECISN.FOR

Purpose and Method:

The purpose of this routine is to enable the user to get an estimate of force effectiveness.

First, the weights and parameters used in the subroutine are initialized. Then a short menu is displayed listing the options. Whenever an option is executed, the totals used are set to zero and both graphs are initialized. A loop is then entered and effectiveness computed (described

in Users' Manual) for all systems in the equipment array. Weights are only applied to the totals (option 2).

The program then checks for option selected. For option 1 or 2, graphs are output form the appropriate arrays. If option 3 or 4 is selected, the player can change weights and parameters used in computing force effectiveness.

Major Variables:

fini - logical; used to control the end of routine

wtmob - real; weight of mobility in equation

wtcr - real; weight of comm range in equation

wtcrs - real; weight of skip comm range in equation

wtsec - real; weight of security factor in equation

wtc3 - real; weight of c3 effectiveness in equation

wtc3s - real; weight of skip c3 effectiveness in equation

wtbm - real; weight o number of sat beams in equation

wtewf - real; weight of ewf in equation

wtecm - real; weight of ecm in equation

wtesm - real; weight of esm in equation

mobhi - integer;scaling factor for mobility

icrhi - integer; scaling factor for comm range

icrshi - integer; scaling factor for skip comm range

c3hi - real; scaling factor for c3

c3shi - real; scaling factor for skip c3

bmhi - real; scaling factor for sat beams

iewfhi - integer; scaling factor for ewf

iecmhi - integer; scaling factor for ecm

iesmhi - integer; scaling factor for esm

itime - integer; decision time left

totmob(5) - real; total adjusted mobility for year I

totcr(5) - real; total adjusted comm range for year I

totcrs(5) - real; total adjusted skip comm range for year I

totsec(5) - real; total adjusted security factor for year I

totc3(5) - real; total adjusted c3 for year I

totc3s(5) - real; total adjusted skip c3 for year I

totbm(5) - real; total adjusted sat beams for year I

totewf(5) - real; total adjusted ewf for year I

totecm(5) - real; total adjusted ecm for year I

totesm(5) - real; total adjusted esm for year I

fci(10,70) - character * 1; holds the force capability index display

fca(25,54) - character * 1; holds the force capablitiy assessment display

it1,it2,it3,it4,it5 - integer; 5 years of the forecast

v(5) - real; value of 0 or 1 used in equation to turn on or off certain values

irdy - integer; holds the year a system will be operating

dmob - real; holds the scaled mobility rate

dcrng - real; holds the scaled comm range rate

dcrngs - real; holds the scaled skip comm range rate

dc3e -real; holds the scaled c3 rate

dc3es - real; holds the scaled skip c3 rate

dbeams - real; holds the scaled sat beam rate

dewf - real; holds the scaled ewf rate

decm - real; holds the scaled ecm rate

desm - real; holds the scaled esm rate

Common Variables Referenced but Not Changed:

stopat	iturn	iplayr	nbreqp
igexp	irexp	gyrrdy	ryrrdy
mdtime	gitem	ritem	igacc
iracc	igfrd	irfrd	igmnfd
irmnfd	igbuy	irbuy	geff
reff	mob	crng	crngs
sec	c3e	c3es	beams
ewf	ecm	esm	

Subprograms Called:

Subroutine PAGE

Entries:

Subroutine PROCUR

SUBROUTINE BUYSYS

File: BUYSYS.FOR

Purpose and Method:

This routine is used to place the systems finishing manufactoring for deployment into normal or reduced operations and maintenance.

The equipment files are searched for the flag IRBUY/IGBUY. If the flags are equal to one then the system is ready for O+M. The player then has the opportunity to place the system in normal or reduced O+M.

Common Variables Changed:

gbgusd rbgusd igbuy irbuy

geff   reff

Common Variables Referenced but Not Changed:

iplayr nbreqp redbgt grnbgt
nomcst romcst gitem   ritem

Entries:

Subroutine PROCUR

SUBROUTINE SCRAP

File: SCRAP.FOR

Purpose and Method:

SCRAP is used to remove any system from the equipment array. It will also add back the money used by the system for that year.

The screen is cleared. Then, all systems in the equipment file are displayed with the state of the systems. The header contains decision time and budget information. A system is selected to be scrapped via the menu number. The program then displays the system to be scrapped and a message is shown displaying money to be saved. The player then confirms the scrapping.

Major Variables:

itmnbr - integer; the reference number of the system to be scrapped

hhmmss - character * 8; time of day

idectm - integer; decision time left

budget - real; budget of Red/Green Player

bgtogo - real; money left player

stat1,stat2,stat3,stat4 - character * 4; status of systems

npage - integer; used in terminal display

money - integer; money status before and after scrapping

i1,i2,i3,i4 - integer; used with npage tc fix up terminal display

Common Variables Changed:

qbgusd
rbgusd

Common Variables Referenced but Not Changed:

stopat	iplayr	grnbgt	redbgt
nbreqp	gsystm	rsystm	geff
reff	iturn	gyrrdy	ryrrdy
igacc	iracc	igexp	irexp
igmnfd	irmnfd	nomcst	romcst
gitem	ritem	mdcost	igbuy
irbuy	igfrd	irfrd	

Subprograms Called:

Subroutine PAGE
Subroutine TIME
Subroutine CANCEL

Entries:

Subroutine PROCUR

SUBROUTINE CANCEL

File: CANCEL.FOR

Purpose and Method:

This routine subtracts the system from the equipment array.

Parameters:

itm - integer; an index to the sytem to be scrapped

Common Variables Changed:

gsystm	rsystm	gitem	ritem
geff	reff	gyrbgt	ryrbgt
gyrrdy	ryrrdy	igrcst	irdcst
igbuy	irbuy	igacc	iracc
igexp	irexp	igred	irred
igmnfd	irmnfd		

Entries:

Subroutine CANCEL

SUBROUTINE RDACCL

File: RDACCL.FOR

Purpose and Method:

The Red/Green Player can place a system in accelerated research and deveopment.

First, go through the equipment array determining systems available for R+D and save the pointers in an array. Then display all systems available for R+D on the player's terminal. This is done via the index saved earlier and a format routine to place the data on the terminal. The Red/Green Player enters the selection. The program then asks for another system.

Major Variables:

fini - logical; controls end of program

nmnd - integer; number of systems available for R+D

ndex(200) - integer; pointer to the systems available for R+D

itmnbr - integer; selected system reference

idectm - integer; decision time left

pge - real; used to align display

npage - integer; used to align display

i1,i2,i3,i4 integer; used to align display

iyr1,iyr2,iyr3,iyr4 - integer; holds year for display

Common Variables Changed:

gbgusd	rbgusd	gyrbgt	ryrbgt
gyrrdy	ryrrdy	igbuy	irbuy
igacc	iracc	igexp	irexp
igred	irred	igmnfd	irmnfd
gsystm	rsystm		

Common Variables Referenced but Not Changed:

stopat	nbreqp	iplayr	ardtim
gitem	ritem	grnbgt	redbgt
iturn	ardcst		

Subprograms Called:

Subroutine PAGE

Entries:

Subroutine PROCUR

SUBROUTINE RDEXPN

File: RDEXPN.FOR

Purpose and Method:

The Red/Green Player can place a system in normal R+D. The description is the same as Accelerated R+D except that cost and time are taken from 'RDCOST, RDTIME'.

Entries:

Subroutine PROCUR

SUBROUTINE OMRED

File: OMRED.FOR

Purpoce and Method:

This routine is used to save money by placing a system that is in normal O+M into a reduced operating state.

The number of systems in normal O+M is first computed. The menu of systems available to be reduced is displayed along with the money to be saved. The Red/Green Player selects the system to be reduced. The player then is asked to verify the reduction.

Major Variables:

fini - logical; controls when program ends

nmnd - integer; number of systems to reduce

ndex(200) - integer; index to systems available to reduce

bgtlft - real; amount of budget left

idectm - integer; decision time left

pge - real; used for terminal display

npage - integer; used for terminal display

i1,i2,i3,i4 - integer; used for terminal display

iyr1,iyr2,iyr3,iyr4 - integer; years displayed

isave1,isave2,isave3,isave4 - integer; money to be saved

itmnbr - integer; selected system to reduce

Common Variables Changed

gbgusd   rbgusd
geff   reff

Common Variables Referenced but Not Changed:

stopat nbreqp iplayr grnbgt
redbgt rdtime gitem ritem
nomcst romcst gsystm rsystm

Subprograms Called:

Subroutine PAGE

Entries:

Subroutine PROCUR

SUBROUTINE PINTEL

File: PINTEL.FOR

Purpose and Method:

The purpose of this routine is to request intelligence information and to comment to the controller.

A menu is displayed to Red/Green Player with options avaiable. After an option is selected, the program opens the INTEL file. The file is checked for previous general intel request for that year (so you will not pay for general intelligence more than once). The budget is also checked to insure enough money is left to purchase intelligence. If specific intel is requested, a menu of all systems will be displayed. The player enters the reference number of the system desired. The program then asks Red/Green questions on intel desired. If option -3- is chosen, the player may enter a free format message to the controller.

Major Variables:

infgen - integer; a flag set if general intel is requested

fini - logical; controls exit from routine

budget - real; budget given player

bgtlft - real; budget left to spend

itime - integer; decision time left

hhmmss - character * 8; time of day

intype - character * 1; option chosen

intfil - character * 20; intel file name

iunit - integer; intel file unit

icost - integer; cost of intel for a type of request

intyr - integer; next year

rtyp - character * 2; intel record type

ignr/jgnr - integer;general intel request flags

isr/jsr - integer; specific intel request flags

insyst/onsyst - character * 8; system on which intel is desired

ist/jst - integer; not used

infrd/jnfrd - integer; R+D intel desired flag

inby/jnby - integer; is sytem going to be bought flag

inamt/jnamt - integer; how many systems to be bought flag

indte/jndte - integer; date system available flag

msg - character * 80; message from player to Umpire

npage - integer; used in terminal display

i1,i2,i3,i4 - integer; used in terminal display

Common Variables Changed:

gbgusd
rbgusd

Common Variables Referenced but Not Changed:

iplayr grnbgt redbgt stopat

iturn nbrsys system etype

Subprograms Called:

Subroutine PAGE

Entries:

Subroutine PROCUR

SUBROUTINE MDEPLY

File: MDEPLY.FOR

Purpose and Method:

The Red/Green Player can place a system in manufacturing for deployment.

.First, go through the equipment array to determine systems available for M+D and save the pointers in an array. Then, display all available for M+D on the player's terminal. This is done via the index saved earlier and a format routine to place the data on the terminal. The Red/Green Player enters the selection. The program then asks for another system.

Major Variables:

fini - logical; controls end of program

nmnd - integer; number of systems available for M+D

ndex(200) - integer; pointer to the systems available for M+D

itmnbr - integer; selected system reference

idectm - integer; decision time left

pge - real; used to align display

npage - integer; used to align display

i1,i2,i3,i4 integer; used to align display

iyr1,iyr2,iyr3,iyr4 - integer; holds year for display

Common Variables Changed:

gbgusd	rbgusd	gyrbgt	ryrbgt
gyrrdy	ryrrdy	igbuy	irbuy
igacc	iracc	igexp	irexp
igred	irred	igmnfd	irmnfd
gsystm	rsystm		

Common Variables Referenced but Not Changed:

stopat	nbreqp	iplayr	iturn
rdtime	gitem	ritem	gsystm
rsystm	grnbgt	redbgt	mdtime
mdcost			

Subprograms Called:

Subroutine PAGE

Entries:

Subroutine PROCUR

5. THE OPERATIONS PHASE

5.1 PROGRAMMING STYLE

As much as oossible, the Operations Phase is written in structured FORTRAN in a very simple style so that it can be modified by novice programmers. Modules are small, with frequent comments as to their purpose, and with extensive use of subroutines and functions. Only four basic structures are used:

a. The DO WHILE

```
        DO WHILE (XXX)
            .
            .
        END DO
```

b. The DO UNTIL

```
     10 CONTINUE
            .
            .
        IF (XXX) GO TO 10
```

c. The DO FOR

```
        DO 10 I=M,N
            .
            .
     10 CONTINUE
```

d. The IF-THEN-ELSE-IF

```
        IF (XXX) THEN
            .
            .
        ELSE IF (XXX) THEN
            .
            .
        END IF
```

Sentinals are used extensively. The system, equipment, unit, and key objective data files all end with a '-1' as a sentinal. Most modules use at least one loop that searches a list until the sentinal is found.

The primary exceptions to structured FORTRAN are in the control modules described in Section 3 and in the error checking described in Section 5.2.

5.2 ERROR CHECKING

There are four types of error checks used in the Operations Phase. When reading from the terminal, if the system detects an error, such as a letter when a number is expected, a return to the same question will result. The sequence would look like this:

```
      10 WRITE (6,1000) QUESTION
         READ (5,2000,ERR=10) ANSWER
```

When reading from a file, an end of file marker will cause an escape from the loop. For example:

```
         i = 1
         DO WHILE (redunt(i) .ne. '-1')
            READ (16,1000,ERR=10) rrow(i),rcol(i)
              .
              .
              .
            i = i + 1
         END DO
     10  CONTINUE
```

The third type of error check is a check of the logic of an answer. This type of check uses structures inside the module itself. For example, the input name of a unit to be airlifted is checked against the list of units to make sure

it is a valid name; then the unit type (rforce or aforce) is checked to see if the unit is airmobile. If it is not a valid unit name, an error message appears and the program either askes for a new name or returns to a menu selection. In some cases where it repeatedly asks for a new name, the program will accept the word 'stop' as a signal to return to a menu.

The fourth error check is a logical check of hex coordinates. Any time hex coordinates are entered at the terminal, Subroutine CHECK is called to verify them. It checks to make sure the numbers are not larger than the map and that they are both odd or both even. If they are not valid coordinates, the subroutine types an error message and asks for new coordinates until it gets valid ones.

5.3 STRUCTURE OF THE OPERATIONS PHASE

5.3.1 Game Sequence

The two players and the Umpire are operating in a timed sequence controlled by the modules described in Section 3. The main portion of the Operations Phase is a large DO WHILE loop that continues until the ENDWAR subroutine sets the logical flag OVER to true. The sequence of the loop is as follows:

a. The Umpire sets the rules of engagement.

b. In turn 1, the players assign electronic equipment to units or locations.

c. In turns other than 1, intelligence requested in the last turn is output to the players.

d. The players have a timed turn in which they change movement goals, assign air missions, request intelligence, etc.

e. The Umpire's program moves the units toward their destinations. If conflict situations arise the players are asked whether or not they want to attack or retreat.

f. Any attack requests are referred to the level required by the rules of engagement.

g. If attacks are approved, interdiction, close air support, counter air, and ground combat are conducted.

h. The Umpire is given the opportunity to end the game or repeat the loop for another turn.

The game sequence described above results from a complex heirarchy of modules, described in Section 5.6.

5.3.2 Common Variables

The Operations Phase uses 17 sets of common variables which are referenced and/or changed by the various modules. These variables are of seven main types:

a. Map descriptions
b. Electronic system descriptions
c. Unit descriptions
d. Action request details
e. Frequently used character variables
f. Game control variables

Many of these variables are initially input from data files, others by particular modules. The variables are defined in

Section 5.5; the module descriptions in Section 5.6 identify the common variables that are referenced and/or changed by each module.

5.3.3 Interfaces

There are two types of interfaces between the players and the Umpire. The first type of interface is by message; the active module can write messages to files 40 (for Red-Umpire messages) or 41 (for Green-Umpire messages). The inactive, waiting terminal periodically checks the files for messages and returns the answer or a dummy answer to the file, to be read by the active terminal. The routines used for this purpose are Subroutines RLISTEN, GLISTEN, RMSG, and GMSG, which are described in Section 3.4.

The second type of interface is via blackboards. When control of the game is passed from the Umpire to the players, the Umpire writes all common variables to files 25 (SYSBRD.DAT), 26 (REDBRD.DAT), and 27 (GRNBRD.DAT) using Subroutines SYSOUT, REDOUT, and GRNOUT. The players then read all three of the blackboards using Subroutines SYSBRD, REDBRD, and GRNBRD. The player's actions can change only the information in the blackboard of the same color, but cannot change either the system blackboard or the other player's blackboard. When they are finished they write only the blackboard of their color, using Subroutines REDOUT or GRNOUT. The Umpire reads all the blackboards and can make changes to any of them.

5.4 MODIFICATION

5.4.1 Modification of the Control Sequences

Modifications of Subroutines OPNCTL, REDOPS, GRNOPS, RLISTEN, GLISTEN, RMSG, and GMSG require more than novice level programming knowledge and should be undertaken accordingly. See Section 3.4 for further information.

5.4.2 Modification of Data Lists

Input data changes can be made easily, but details such as file columns are important. To modify a data file, such as the system list, establish a new file, for example SYSTEM2.DAT, and copy the default file into it. Use the editor to make any desired changes, being sure to keep the column formats and data types unchanged. The new file can be substituted for the default file by the Umpire, merely by selecting Option 5 "MOD GAME: TAILOR DATA FILES" in the "COMEL WAR GAME OPTIONS" menu and giving the filename of the new file (See COMEL CONTROL PROGRAM in Section 3.4).

5.4.3 Single Module Changes

Some changes require only one module to be modified (or one Red module and the mirror image Green module). For instance the terrain effect on communications is moduled in Subroutines RTERAIN and GTERAIN. The effect of terrain on movement is modeled in Real function PNTS.

To make a change to a single module, copy the module to a new file, make the changes, and then compile the file. Copy the original with no changes to a separate file to save it in case you later want to reinsert it. Add your new routine to the executable library file by the following sequence of commands: [Ref. 5]

```
$ LIBRARY/REPLACE WARLIB [C/R]
$ FILE:      filename  [C/R]
```

The filename entered should be that of your new routine. The program must then be relinked with the commands:

```
$LINK UMPIRE,ACQUIS/LIB,WARLIB/LIB [C/R]
$LINK PLAYER,ACQUIS/LIB,WARLIB/LIB [C/R]
```

The executable file of the game will now include the new routine until the LIBRARY/REPLACE and LINK commands are repeated, replacing the original version or inserting still another new version of the same module.

If your new module doesn't work, compile and replace the original version into the executable file in the same way. If your version does work and you want to make the change permanent, include your module in the source file (UMPFILE.FOR, RED.FOR, or GREEN.FOR) ,in place of the original. (The location of each module is listed in the file descriptions in Section 5.6.) Document your change by making the necessary corrections to the User's and Maintenance Manuals.

For example, to change the Subroutine ENEMY, check the module listings in Section 5.6 of this manual to see that ENEMY is in file GENERAL.FOR. Use the editor tc create a new file, ENEMY2.FOR. Include GENERAL.FOR in the rew file and delete everything except ENEMY. Make the desired changes to Subroutine ENEMY then exit the file and compile the new version. Substitute the new version for the old one in the library with the LIBRARY/REPLACE command, entering the filename ENEMY2 on the second line. Link the program and test it. To replace the original version of ENEMY, compile GENERAL.FOR and replace it in the library and relink. To make the new version of ENEMY permanent, edit GENERAL.FOR, deleting the old version and including the new one in it's place.

5.4.4 <u>New Electronic System Types</u>

To add a new type of electronic system, such as laser communications, satellite jammers, airborne electronic warfare, etc. the easy part is adding the system to the system data file with appropriate system data information. You then must review the input routine, the terrain sequences, the communications effectiveness functions, the player action modules, and the combat sequence modules to see if any changes are needed to implement the new system. If any modules must be changed, modify and insert each change as described in Section 5.4.3, test the changes thoroughly, and revise the documentation.

5.4.5 New Unit Types

To add a new type of unit, such as a light infanty brigade or a ground reconnaissance squadron, add the unit to the data files with appropriate combat, air defense and other values. Then review the input, player action, and combat sequences to see if changes are needed. Implement and document as described earlier.

5.4.6 Revisions of Combat Models

A change to close air support, counter air, interdiction, movement, intelligence, or ground combat modules may involve changing several routines. If you want to change a particular module, check especially its parents in the heirarchy tree by tracing the entries, and its children, by tracing the programs called (listed in each module description). Most player action modules are tied closely to one or more Umpire modules. For example, RRECON and GRECON set variables triggering OPINTEL. Be sure to check both player and Umpire modules for necessary changes. Implement and document your changes as previously described.

5.5 COMMON VARIABLES (OPERATIONS PHASE)

/hex/

hex(66,60) - character*1; for each hex in the map, identifies the terrain as open, woods, mountain, desert, sea, or lake

owner(66,60)- character*1; for each hex, identifies whether presently neutral, or occupied by red, green, or both

lasown(66,60)- character*1; identifies the last side to have been in each hex

/rhex/

rhex(66,60)-integer; 2 for hexes on one bank of a river and 1 for hexes on the other side; 0 for hexes not on bank

vhex(66,60)-integer; 1 for hexes containing road, 0 otherwise

keya(20,2)-integer; row and column of major objectives

keyb(20,2)-integer; row and column of minor objectives

/system/

system(50)-character*8; equipment nomenclature

etype(50)-character*5; classifies each system by type

noa(50)-integer; number of end items of each kind available

rdcost(50)-integer; cost in $M for Research and Development of system

rdtime(50)-integer; time in years required for R+D

ardcst(50)-integer; cost for accelerated R+D

ardtim(50)-integer; time for accelerated R+D

mdcost(50)-integer; cost for manufacturing and deployment

mdtime(50)-integer; time in years for M+D

nomcst(50)-integer; cost of normal operating and maintenance

romcst(50)-integer; cost of O+M at reduced readiness

mob(50)-integer; mobility in hexes per turn

crng(50)-integer; communications range in hexes; beamwidth of satellites

crngs(50)-integer; for HF equipment, skywave range

sec(50)-integer; security factor; ability to resist jamming and intrusion

rel(50)-real; reliability

rels(50)-real; reliability of HF equipment in skywave operation

flex(50)-real; flexibility

opt(50)-real; opt ?????

c3e(50)-real; C3 effectiveness

c3es(50)-real; C3 effectiveness of HF in skywave operation

ewf(50)-integer; Electronic Warfare effectiveness; ability of EW equipment to overcome the security factor of communications equipment

ecm(50)-real; effectiveness of jamming

esm(50)-integer; ability to detect emisions

beams(50)-integer; for satellites, the number of beams

/table/

table(50,50)-character*1; compatibility table; n if not compatible; t if compatible; w if compatible only with wire connection; g if wire connection only in same hex

ncapat(50)-character*1; compatibility of equipment with systems at NCA

/table2/

table2(10,10,6)-integer; combat results table

/redunt//grnunt/

redunt/grnunt(20)-character*8; names of combat units

rforce/gforce(20)-character*5; type of unit

/redpos//grnpos/

rrow/grow(20)-integer; row location of unit

rcol/gcol(20)-integer; column location of unit

rumob/gumob(20)-integer; mobility of unit

rgoal/ggoal(20,2)-integer; destination of unit

rcmbtp/gcmbtp(20)-real; combat points of unit

radno/gadno(20)-integer; air defense value of unit

rcasv/gcasv(20)-integer; close air support value of air wing

rcav/gcav(20)-integer; counter air value of air wing

rewv/gewv(20)-integer; ability of air wing to use jammers and other tactics to overcome enemy air defenses

rcnlst/gcnlst(20)-integer; identifies intentions of unit in enemy control zone; 4 if unit was last to arrive and wishes to attack; 3 if unit was first to arrive and wishes to attack; 2 if unit is defensive only

rseal/gseal(10,2)-integer; sealift information; task force and marine indexes in unit list

rown/gown(10,3)-integer; list of changes to owner matrix; row, col, and value of hex

rlas/glas(10)-integer; corresponding value of lasown hex

/redeq//grneq/

redeq/grneq(100)-character*8; nomenclature of equipment

raunit/gaunit(100)-character*8; mobile equipment unit assignment

rmode/gmode(100)-character*5; ESM or ECM mode of operation for EW equipment

/reqpos/geqpos/

reqrow/geqrow(100)-integer; row location of equipment

reqcol/geqcol(100)-integer; column location of equipment

ritem/gitem(100)-integer; system number of equipment; link to system list using the index number in that list

rtc3e/gtc3e(100)-real; temporary C3 effectiveness, based on basic c3e value, terrain and jamming effects

rtc3es/gtc3es(100)-real; temporary C3E of HF in skywave ops

rtcrng/gtcrng(100)-integer; temporary range, after terrain effects

rbeam/gbeam(100,10,2)-integer; center of satellite beams

rrom/grom(100)-real; percentage of normal effectiveness due to reduced readiness (because of cost cutting in Acquisition Phase of game)

<u>/redwar//grnwar/</u>

rintd/gintd(20,5,2)-integer; target locations for interdiction

rtintd/gtintd(20)-integer number of interdiction missions possible in this turn by this air wing

rtcasv/gtcasv(20)-integer; temporary close-air-support value of an air unit; based on normal value, comm effectiveness and jamming

rtcav/gtcav(20)-integer; temporary counter-air value

rrecce/grecce-integer; number of reconnaisance missions requested

rpathr/gpathr(20,50)-integer; row values of projected path to goal; for air wings, route of recce photo run

rpathc/gpathc(20,50)-integer; column values of path

rstart/gstart(20)-integer; next hex in path

rend/gend(20)-integer; last hex in path

rlenth/glenth(20)-integer; length of path in movement points

rab/gab-integer; index number of airborne command posts

rabl/gabl(10)-integer; list of index numbers of all ABNCP

raba/gaba-integer; ABNCP presently on call

ricol/gicol(100)-integer; left hand column for intelligence satellite to survey

raw/gaw-integer; lindex number of AWACS

rawl/gawl(10)-integer; list of index numbers of all AWACS

rawa/gawa-integer; AWACS presently on call

ravalb/gavalb-real; probability of ABNCP being operational; based on number purchased

ravalw/gavalw-real; probability of AWACS being available

rlift/glift-integer; index number of unit being airlifted

rdrop/gdrop(2)-integer; location of drop zone

rland/gland-integer; index number of unit being debarked from sealift

rshore/gshore(2)-integer; location of landing

rtargt/gtargt-integer; index number of satellite being targeted

rweapn/gweapn-integer; index number of anti-satellite weapon

/words/

jtfhq - character*5; JTFHQ

armor - character*5; armored brigade

relay - character*5; communications relay or EW detachment

mech - character*5; mechanized brigade

cbg - character*5; carrier battle group

atf - cqaracter*5; amphibious task force

abn - character*5; airborne brigade

tfw - character*5; tactical fighter wing

amph - character*5; Marine amphibious brigade

air - character*5; type unit used in getting direct path from optimum path routine (not affected by terrain)

gtsat - character*5; satellite ground terminal

abncp - character*5; airborne command post

awacs - character*5; AWACS

ew - character*5; EW iquipment

tac - character*5; tactical equipment

hf - character*5; hf equipment

los - character*5; line-of-sight equipment

sat - character*5; communications satellites

vlf - character*5; vlf equipment

sw - character*5; switching system

spy - character*5; intelligence satellite

asat - character*5; anti-satellite weapon

red - character*1; 'r'; Red Player

grn - character*1; 'g'; Green Player

/game/

gamtrn-integer; number of present operations turn; day number

seed-integer; seed for random number generator

delta-integer; length of turn in seconds

5.6 THE OPERATIONS MODULES

SUBROUTINE INPUT ()

File: UMPFILE.FOR

Purpose and Method:

This routine opens and reads the data files necessary for the Operations Phase.

Open and read files for map data and system information. Read lists of equipment; if file is empty, call Subprogram INITIAL to build new list. Determine whether Umpire wants to build a new unit list; if so call Subroutine UNITLIST; if not, read default list. Open and read combat results table. Open blackboards.

Common Variables Changed:

hex	ardtim	ewf	rcmbtp/gcmbtp
rhex	nomcst	ecm	radno/gadno
vhex	romcst	esm	rcasv/gcasv
keya	mob	beams	rcav/gcav
keyb	crng	table	rewv/gewv
system	crngs	ncapat	redeq/grneq
etype	sec	table2	rtc3e/gtc3e
noa	rel	redunt/grnunt	rrom/grom
rdcost	rels	rforce/gforce	ritem/gitem
rdtime	flex	rrow/grow	rseal/gseal
mdcost	oot	rcol/gcol	owner
mdtime	c3e	rumob/gumob	lasown
ardcst	c3es	rgoal/ggoal	gamturn

Subprograms Called:

Subroutine INITIAL
Subroutine UNITLST

Data Files Accessed and File Name:

11 - Hex data	HEX.DAT
12 - Road data	RHEX.DAT
13 - River data	VHEX.DAT
14 - System list	SYSTEM.DAT

15	Red equipment list	REQUIP.DAT
16	Green equipment list	GEQUIP.DAT
17	Red unit list	REDUNIT.DAT
18	Green unit list	GRNUNIT.DAT
19	Compatibility table	TABLE.DAT
20	Combat outcomes table	TABLE2.DAT
21	Key objectives	KEY.DAT
25	System and map blackboard	SYSBRD.DAT
26	Red blackboard	REDBRD.DAT
27	Green blackboard	GRNBRD.DAT

Entries:

Subroutine OPNCTL

SUBROUTINE INITIAL ()

File: UMPFILE.FOR

Purpose and Method:

This routine allows the Umpire to build new initial equipment lists for the Red and Green forces.

For each system, output name and number available. Input number allocated to Green forces and add to equipment list, setting equipment name equal to system name, and setting other variables as appropriate. Ask whether the equipment is to be operated at full or reduced readiness. Repeat for Red forces. Adjust number available. Set sentinels.

Major Variables

rnum/gnum - integer; number of items of each syster to out in list

rcount/gcount - integer; total number of items on list

Common Variables Changed

rmode/gmode ritem/gitem

redeq/grneq rrom/grom
noa

Common Variables Referenced but Not Changed:

system

Entries:

Subroutine INPUT

SUBROUTINE UNITLST ()

File: UMPFILE.FOR

Purpose and Method:

This routine allows the Umpire to set up the opposing forces.

Input unit names until sentinel is entered. Enter the Green JTFHQ name first, then other Green units. For each unit other than the JTFHQ, determine type of unit and set GFORCE and GUMOB accordingly. Enter location; set initial goal to stationary (0,0); set combat points to default. Based on type of unit, set air defense, close air support, counter air, ew, and combat values. Repeat for Red forces.

Common Variables Changed:

redunt/grnunt	rgoal/ggoal	rewv/gewv
rforce/gforce	rcmbtp/gcmbtp	owner
rumob/gumob	radno/gadno	lasown
rrow/grow	rcasv/gcasv	
rcol/gcol	rcav/gcav	

Subprogram calls:

Subroutine CHECK

Entries:

Subroutine INPUT

<u>SUBROUTINE OPINTEL</u> ()

File: UMPFILE.FOR

Purpose and Method:

This subroutine provides players with intelligence information according to the satellite survey corridors and recce flights requested in the previous turn, and from ew equipment that is in the ESM mode.

For each Red Tactical Air Wing, check C3EXT. If comm is up, check each hex in listed path for enemy units and write msg to appropriate player. Do same for Green TFWs. For each Red intelligence satellite, check to see if the JTFHQ has connectivity to NCA to receive the data (if a random number is less than NCACON). Then find the indicated column and use the crng to determine the beamwidth; then survey those columns for enemy units. For Red EW equipment in the ESM mode, check compatibility and range to enemy transmitters. Do same for Green equipment.

Major Variables:

row,col - integers; hex being inspected

iangle - integer; rounded value of bearing from ESM equipment to enemy emitter

rn - real; random number

rcomm/gcomm - real; external comm effectiveness of air wing flying recon; ability to pass recon information to HQ

rnca/gnca - real; connectivity to NCA; ability to

connect to conus to request and receive satellite intelligence

rng - integer; distance from air wing to JTFHQ

div - real; interim value used in calculating iangle

power - integer; ability of ESM to overcome security of comm systems

airpow - integer; total combat power of air wing

ray - logical; flag indicating an ESM system has detected a comm system

x - logical; true if ew system is effective against a given comm system

Common Variables Referenced but Not Changed:

redunt/grnunt	reqrow/geqrow	rcav/gcav
rforce/gforce	reqcol/geqcol	rewv/gewv
rrow/grow	rtcrng/gtcrng	owner
rcol/gcol	ricol/gicol	etype
rpathr/gpathr	rcmbtp/gcmbtp	esm
rpathc/gpathc	rmode/gmode	sec
redeq/grneq	rcasv/gcasv	seed
ritem/gitem	rtc3e/gtc3e	

Subprograms Called:

Subroutine RLISTEN/GLISTEN
Integer function RANGE
Real function C3EXT
Real function NCACON
Logical function COMPAT
System functions RAN, ABS, ATAN, and IFIX

Entries:

Subroutine OPNCTL

SUBROUTINE EWCHECK ()

File: UMPFILE.FOR

Purpose and Method:

This subroutine checks each piece of EW equipment in the ECM mode and determines if it is an effective jammer against any enemy comm equipment. It then adjusts the temporary c3 effectiveness of the affected comm gear.

Check Red equipment lists for EW equipment in ECM mode. Check enemy comm gear for range and compatibility with EW gear. If effective, adjust temporary C3 effectiveness of enemy gear by an amount proportional to the ECM value of the EW equipment. Repeat for Green EW equipment.

Major Variables:

diff - integer; difference between ew factor and security factor of EW and comm equipment

rng - integer; range from EW to comm equipment

x - logical; true if EW system is effective against comm

Common Variables Changed:

rtc3e/gtc3e
rtc3es/gtc3es

Common Variables Referenced but Not Changed:

redeq/grneq	rtcrng/gtcrng	ecm
ritem/gitem	reqrow/geqrow	ewf
rmode/gmode	reqcol/geqcol	ecm
etype	seed	sec

Subprograms Called:

Integer function RANGE
Logical function COMPAT
System functions RAN and IFIX

Entries:

Subroutine COMBAT

SUBROUTINE CA (RATIRT,GATTRT,RRESLT,GRESLT)

File: UMPFILE.FOR

Purpose and Method:

This routine calculates the outcome of counter air (air-to-air) battles when air forces of one side, enroute to their missions, are intercepted by air forces of the other side.

Total counter air value of Red air forces. Total counter air value of Green air forces. Calculate score of air battle as the difference between counter air values of the forces. Based on score and random number, determine with internal tables (Figure A-8 of Users' Manual) which air forces are attritred, whether the other missions continue or abort, and whether counter air capability is decreased.

Parameters:

rattrt/gattrt - logical; true if air forces sustain losses in the air battle

rreslt/greslt - logical; true if mission is to continue, false if it must be aborted

Other Major Variables:

rcat/gcat - integer; total temporary air value of one side

comm - real; internal C3 effectiveness of air unit

score - integer; score in counter-air battle

rn - real; random number

irn - integer; random integer

Common Variables Changed:

rtcav/gtcav

rcav/gcav

Common Variables Referenced but Not Changed:

redunt/grnunt	rrow/grow
seed	rcol/gcol

Subprograms Called:

Real function INTC3
System functions RAN and IFIX

Entries:

Subroutine DICTION
Subroutine RSTRIKE/GSTRIKE

SUBROUTINE DICTION (FIRST)

File: UMPFILE.FOR

Purpose and Method:

This module deducts recce flights from other air capability of each side and determines if interdiction strikes are permitted.

If any recce missions were flown, subtract them from the total number of interdictions that can be flown. If any interdiction capability remains, and missions were requested, then check to see if rules of engagement require approval from NCA. Call up strikes. Since recce flights take priority over all other air missions, if there are still recce missions not accounted for (they outnumbered the interdiction missions) decrease the temporary close air support value and counter air value of the air forces. Repeat the process for Green missions.

Parameters:

first - integer; number indicates rules of engagement

Other Major Variables:

rn - real; random number

comm - real; connectivity to NCA

strikr - character*3; attacker

strikes - integer; number of strikes possible

Common Variables Changed:

rrecce/grecce	rtcasv/gtcasv
rintd/gintd	rtcav/gtcav
rtintd/gtintd	

Common Variables Referenced but Not Changed:

redunt/grnunt	rrow/grow
seed	rcol/gcol

Subprograms Called:

Subroutine RLISTEN/GLISTEN
Subroutine RSTRIKE/GSTRIKE
Real function NCACON
System function RAN

Entries:

Subroutine OPNCTL

SUBROUTINE RSTRIKE/GSTRIKE (FIRST)

File: UMPFILE.FOR

Purpose and Method:

This routine determines the results of any approved interdiction missions.

If the enemy has AWACS, conduct counter air before the interdiction mission. If attrition results from counter air (see Subroutine CA), reduce effectiveness of the offensive air unit by reducing the EW value. Notify payer if mission must be aborted. If mission is not aborted, determine if any enemy units are in the target area. Conduct ground air defense by contrasting the EW value of the aircraft with the air defense value of the ground unit. Use an internal table (Figure A-9 of the Users' Manual) to compare the difference with a random number. If interdiction attack gets through the counter air and air defense, stop movement of enemy forces and attrit them by reducing their combat points by 1.0. If AWACS was not available to the enemy, conduct counter air after the interdiction.

Parameters:

first - integer; rules of engagement

Other Major Variables:

rn,rn2,rn3 - real; random numbers

irn - integer; integer random number

ad - integer; air defense results

rattrt/gattrt - logical; true if forces incur losses in air-to-air battle

rreslt/greslt - logical; rrue if interdiction mission can continue, false if it must abort

comm - real; external connectivity of air wing and later internal connectivity

rng - intger; range from air wing to JTFHQ

go - logical; true if all comm checks work

Common Variables Changed:

rgoal/ggoal   rewv/gewv
rcmbtp/gcmbatp

Common Variables Referenced but Not Changed:

redunt/grnunt	rtintd/gtintd	radno/gadno
rrow/grow	rintd/gintd	rforce/gforce
rcol/gcol	ravalw/gavalw	seed

Subprograms Called:

Subroutine RLISTEN/GLISTEN
Subroutine CA
Integer function RANGE
Real function C3EXT
Real function INTC3
System functions RAN and IFIX

Entries:

Subroutine DICTION

SUBROUTINE COMBAT (FIRST)

File: UMPFILE.FOR

Purpose and Method:

This subroutine does any anti-satellite firings and initiates combat between enemy units. Priority for attacks goes to Red or Green randomly, then proceeds according to the value of the conflict list (units arriving last and wanting to attack, then units arriving first and wanting to attack). The subroutine also calls Subroutine EWCHECK to adjust temporary C3 and range values for jamming.

Fire any anti-satellite weapons requested by comparing a random number to the C3E of the anti-satellite weapon. Call EWCHECK. Determine randomly whether Red or Green has first chance to attack. Determine order of attacks based on conflict lists, and call appropriate attack module. Write message to player if any defensive units were not attacked. Reverse order if Green is given first chance to attack. Outcome of ground combat is determined in RATTACK/GATTACK and FIGHT subroutines.

Parameters:

first - integer; rules of engagement

Other Major Variables:

rn - real; random number

hit - logical; true if an attack approval has been requested

side - character*5; red or green

Common Variables Changed:

rtc3e/gtc3e	rweapn/gweapn
rcmbtp/gcmbtp	rtargt/gtargt
raunit/gaunit	rcnlst/gcnlst

Common Variables Referenced but Not Changed:

redunt/grnunt
redeq/grneq
seed

Subprograms Called:

Subroutine EWCHECK
Subroutine RATTACK/GATTACK
Subroutine RLISTEN/GLISTEN
System function RAN

Entries:

Subroutine OPNCTL

SUBROUTINE RATTACK/GATTACK (I,FIRST,HIT)

File: UMPFILE.FOR

Purpose and Method:

This routine determines if connectivity exists to get approval for an attack.

Identify hexes adjacent to unit. Determine if any enemy unit is in range for an attack. Check internal communications of unit. Check external communications. If rules of engagement require NCA approval of attacks, check connectivity to NCA. Ask Umpire if he wants NCA to approve attack. If rules of engagement allow JTF approval of attack, NCA connectivity check is not required. If local commanders have attack authority, only the internal comm check is required. If approved, begin attack; otherwise give enemy the opportunity to attack. If attack was aborted because of lack of connectivity, notify player and adjust combat points. Notify player if there is no longer an enemy unit in the area.

Parameters:

i - integer; index number of attacking unit

first - integer; rules of engagement

hit - logical; true if opponent is given opportunity to attack

Other Major Variables:

battle - integer; 2 if attack is aborted for lack of

connectivity

comm - real; connectivity to NCA, then external c3, then internal c3 of attacking unit

r,c,lf,rt,up1,up2,dn1,dn2 - integers; hex numbers of unit location and adjoining hexes

rng - integer; distance from unit to JTFHQ

rn - real; random number

Common Variables Changed:

rcnlst/gcnlst
rcmbtp/gcmbtp

Common Variables Referenced but Not Changed:

redunt/grnunt	rrow/grow
seed	rcol/gcol

Subprograms Called:

Subroutine RATTACK/GATTACK (call each other)
Subroutine RBATTLE/GBATTLE
Subroutine RLISTEN/GLISTEN
Integer function RANGE
Real function NCACON
Real function C3EXT
Real function INTC3
System function RAN

Entries:

Subroutine COMBAT
Subroutine RATTACK/GATTACK (each called by the other)

SUBROUTINE RBATTLE/GBATTLE (I,J)

File: UMPFILE.FOR

Purpose and Method:

This subroutine computes the effect of ESM and terrain on combat value as one unit attacks an enemy unit; it calls subprograms to compute losses due to close air support and ground combat.

Compute effect of ESM on Red combat value by subtracting the EW factor of the EW equipment from the security factor of the enemy's communications equipment and then comparing the difference to a random number. If the difference is greater, add the ESM value of the EW equipment to the combat points of the Red unit. Compute effect of ESM on Green combat value. Compute effect of terrain on attacking unit and defending unit, including additional combat points for mountains, woods, and cities which provide good cover for the forces. Add points if the defensive forces are behind a river. Call for close air support for attacking side. Output combat value entering ground combat phase. Call for ground combat (see Subroutine FIGHT).

Parameters:

i - integer; index number of attacking unit

j - integer; defending unit

Other Major Variables:

rng - integer; distance between units

rn - real; random number

irn - integer; random integer

diff - integer; difference between EW factor and security factor of EW and comm equipment

rtpnt/gtpnt - real; temporary combat points, adjusted

for terrain and esm

x - logical; true if ESM equipment is effective against comm equipment

row,col - integer; location of unit i

r,c - integer; location of unit j

Common Variables Referenced but Not Changed:

redunt/grnunt	raunit/gaunit	ewf
rrow/grow	ritem/gitem	sec
rcol/gcol	rmode/gmode	esm
redeq/grneq	rtcrng/gtcrng	hex
reqrow/geqrow	rcmbtp/gcmbtp	vhex
reqcol/geqcol	etype	seed

Subprograms Called:
Subroutine RCAS/GCAS
Subroutine FIGHT
Subroutine RLISTEN/GLISTEN
Integer function RANGE
logical function COMPAT
System functions RAN and IFIX

Entries:

Subroutine RATTACK/GATTACK

<u>SUBROUTINE FIGHT</u> (SIDE,I,J,RTPNT,GTPNT)

File: UMPFILE.DAT

Purpose and Method:

This subroutine computes the outcome of ground combat between Red unit I and Green unit J.

Compute difference in combat points. Check TABLE2 (Attachment A-11 to the Users' Manual) for combat outcomes, based on the difference in combat points and on a random number. Assign outcomes to appropriate sides. Output losses. If outcome table indicates retreat is necessary for

Red forces, move them back along approach path. Do same for Green retreat. If outcome table indicates Red comm losses result, locate equipment with lowest security factor(sec) and change C3 effectiveness to zero. Do same for Green comm losses.

Parameters:

side - character*1; attacking side, Red or Green

i - integer; index number of Red unit

j - integer; index number of Green unit

rtpnt/gtpnt - real; temporary combat points

Other Major Variables:

diff - integer; integer difference between combat values of the units

rn - real; random number

irn - integer; random integer

gone - integer; index number of comm equipment with lowest security factor; rendered unusable in the battle

rloss/gloss - integer; losses in combat

rret/gret - integer; number of hexes unit must retreat

rcl/gcl - integer; number of comm equiment items rendered unusable

aloss - integer; attacker's loss

dloss - integer; defender's loss

aret - integer; number of hexes attacker retreats

dret - integer; number of hexes defender retreats

acl - integer; number of comm systems attacker loses

dcl - integer; number of comm systems defender loses

mvpnts - real; movement points of unit

min - integer; minimum security value of assigned equipment

Common Variables Changed:

rcmbtp/gcmbtp	rtc3e/gtc3e
rgoal/ggoal	rtc3es/gtc3es
raunit/gaunit	

Common Variables Referenced but Not Changed:

redunt/grnunt	rpathr/gpathr	ritem/gitem
rforce/gforce	rpathc/gpathc	sec
rrow/grow	rstart/gstart	table2
rcol/gcol	redeq/grneq	seed

Subprograms Called:

Subroutine MVMENT
Subroutine RLISTEN/GLISTEN
System functions RAN and IFIX

Entries:

Subroutine RBATTLE/GBATTLE

SUBROUTINE RCAS/GCAS (I,J,RTPNT,GTPNT)

File: UMPFILE.FOR

Purpose and Method:

This subroutine computes the effect of close air support on enemy ground forces.

Find air unit with close air support value remaining. Compute air defense outcome by comparing the EW value of the aircraft with the air defense value of the ground unit. Use an internal table (Figure A-9 of the Users' Manual) to compare the difference with a random number. If CAS aircraft get through enemy air defenses, compute effectiveness against enemy ground forces by

checking the internal communications effectiveness of the air unit. If INTC3 is greater than a random number, decrease the ground unit combat value by 1.0.

Parameters:

i - integer; index number of attacking unit

j - integer; index number of defending unit

rtpnt/gtpnt - real temporary combat values

Other Major Variables:

rn - real; random number

irn - integer; random integer

ad - integer; air defense outcome

comm - real; internal c3 effectiveness of air wing providing close-air-support

done - logical'; true when cas has been provided by one wing; prevents dubplication of effort by another wing

Common variables changed:

```
rewv/gewv          rcmbtp/gcmbtp
rgoal/ggoal
```

Common Variables Referenced but not Changed:

```
redunt/grnunt      rtcasv/gtcasv
rrow/grow          radno/gadno
rcol/gcol          seed
```

Subprograms Called:

Subroutine RLISTEN/GLISTEN
Real function INTC3
System functions RAN and IFIX

Entries:

Subroutine RBATTLE/GBATTLE

SUBROUTINE ENDWAR (OVER)

File: UMPFILE.FOR

Purpose and Method:

This subroutine determines whether either side has won the war in a decisive victory. If not, it gives status to the Umpire and allows the Umpire to decide whether to artificially declare an end to the war with or without a marginal wictory for one side.

Determine if either side controls the major objectives by checking the last owner of hexes listed in KEYA. Determine if either side controls the minor objectives in the same way, using hexes listed in KEYB. If the same side controls both major and minor objectives declare them the decisive victors and end the game. If one side controls the major objectives and the other side controls no minor objectives, the first side has a marginal victory. Allow the Umpire to decide whether to end the game. If one side controls all major objectives but the enemy controls any minor objectives, the outcome is indecisive. Allow the Umpire to decide whether to end the game and whether to declare the first side a winner. If neither side controls the major objectives, there is no winner. Allow the Umpire the option of ending the game in a ceasefire.

Parameters:

over - logical; true if controller decides to end game or if one side has achieved victory

Other Major Variables:

row,col - integers; location of a key objective

major - character*1; side which controls major objectives

minor - character*1; side which controls minor objectives

winner - character*5; side which is winning or ahead

Common Variables Referenced but not Changed:

keya lasown
keyb

Subprogram Calls:

Subroutine RPOSIT/GPOSIT
Subroutine RLISTEN/GLISTEN

Entries:

Subroutine OPNCTL

SUBROUTINE SETOWN ()

File: UMPFILE.DAT

Purpose and Method:

This module sets the OWNER and LASOWN maps to indicate the presence of a newly established unit, designated by the Red or Green Player.

Mark new Red units. Do same for Green. Reinitialize variables to zero for next turn.

Common Variables Changed:

owner rown/gown
lasown rlas/glas

Entries:

Subroutine OPNCTL

SUBROUTINE RULES (FIRST)

File: UMPFILE.FOR

Purpose and Method:

This module allows the Umpire to review and change the rules of engagement.

Write current rule. Ask if rule should be changed; output menu of possible rules.

Parameters:

first - integer; rule of engagement

Entries:
Subroutine OPNCTL

SUBROUTINE MVMENT (I,ROW,COL,NROW,NCOL,MVPNTS,SIDE,FORCE, CNFLCT)

File: GENERAL.FOR

Purpose and Method:

This subroutine moves a unit from one hex to the adjacent hex if the unit has sufficient movement points. It calls Subprogram ENEMY to detect enemy units in adjacent hexes.

Compute number of points required for the move. If the unit has sufficient movement points, make the move, changing the OWNER array if no units from the same side remain in the old hex. Check for enemy units. Set OWNER and LASOWN arrays to indicate presence of unit.

Parameters:

i - integer; index number of unit

row,col - integers; location of unit

nrow,ncol - integers; new location of unit

mvpnts - real; movement points of unit

side - character*1; side unit is on

force - character*5; type of unit

cnflct - logical; true if enemy unit is in same or adjacent hex (to nrow,ncol)

Common Variables Changed:

owner
lasown

Subprograms Called:

Subroutine ENEMY
Real function PNTS

Entries:

Subroutine FIGHT
Subroutine RMOVE/GMOVE

<u>SUBROUTINE ENEMY</u> (ROW,COL,SIDE,CNFLCT)

File: GENERAL.FOR

Purpose and Method:

This subroutine surveys HEX(row,col) and adjacent hexes for enemy units.

Identify adjacent hexes and initialize logical to false. Survey hexes; if owner is other side or both, set logical.

Parameters:

row,col - integers; center hex

side - character*1; side doing check

cnflct - logical; true if other side is present

Other Major Variables:

iu,id,ius,ids,jl,jr - integers; row or column of adjacent hexes

Common Variables Referenced but not Changed:

owner

Entries:

Subroutine FIGHT
Subroutine MVMENT
Subroutine RMOVE/GMOVE

<u>REAL FUNCTION PNTS</u> (SIDE,I,ROW,COL,NROW,NCOL,FORCE)

File: GENERAL.FOR

Purpose and Method:

This function computes the movement points necessary for a unit to move to an adjacent hex.

Get points required to move into a hex of that terrain type from internal data. Adjust by adding one point if the unit must cross a river (if VHEX total of the two hexes is three). Adjust if the unit is moving along a road (if RHEX of both hexes is 1). Check type of unit for sea vs land movement. For air travel, terrain has little effect. When called from RECON module, to set photo recon route, set all hex movement points equal. When called from TERAIN module to establish line-of- sight, set all movement points equal to get nearest possible to straight line.

Parameters:

side - character*1; side moving

i - integer; index number of unit moving

row,col - integers; present location

nrow,ncol - integers; proposed location

force - character*5; type of unit

Other Major Variables:

river - integer; total vhex points of the two hexes; a 3 indicates crossing the river

points - real, number of points required for the move

Common Variables Referenced but not Changed:

hex	rhex
vhex	rseal/gseal

Entries:

Subroutine MVMENT

SUBROUTINE SYSOUT ()

File: GENERAL.FOR

Purpose and Method:

This routine writes all common map and system variables to file #25 for later access.

Common Variables Referenced but not Changed:

References(writes) all common variables from hex, rhex, system, sysacq, sysops, table, table2, and game commons

Entries:

Subroutine OPNCTL

SUBROUTINE REDOUT ()

File: GENERAL.FOR

Purpose and Method:

This module writes all common red variables to file #26 for later access.

Common Variables Referenced but not Changed:

References(writes) all variables from redunt, redpos, redeq, reqpos, and redwar commons.

Entries:

Subroutine OPNCTL
Subroutine REDOPS

SUBROUTINE GRNOUT ()

File: GENERAL.FOR

Purpose and Method:

This module writes all common green variables to file #27 for later access.

Common Variables Referenced but not Changed:

References(writes) all variables from grnunt, grnpos, grneq, geqpos, and grnwar commons.

Entries:

Subroutine OPNCTL
Subroutine GRNOPS

SUBROUTINE SYSBRD ()

File: GENERAL.FOR

Purpose and Method:

This routine reads SYSBRD.DAT (file #25) into the common variables. The formats are the same as for SYSOUT.

Common Variables Changed:

Changes all variables from hex, rhex, vhex, system, sysacq, sysops, table, table2, and game commons.

Entries:

Subroutine OPNCTL
Subroutine REDOPS/GRNOPS

SUBROUTINE REDBRD ()

File: GENERAL.FOR

Purpose and Method:

This module reads REDBRD.DAT (file #26) into the common variables. The formats are the same as for REDOUT.

Common Variables Changed:

Changes (reads) all variables from redunt, redpos, redeq, reqpos, and redwar commons.

Entries:

Subroutine OPNCTL
Subroutine REDOPS/GRNOPS

SUBROUTINE GRNBRD ()

File: GENERAL.FOR

Purpose and Method:

This module reads GRNBRD.DAT (file #27) into the common variables. The formats are the same as for GRNOUT.

Common Variables Changed:

Changes (reads) all variables from grnunt, grnpos, grneq, geqpos, and grnwar commons.

Entries:

Subroutine OPNCTL
Subroutine REDOPS/GRNOPS

INTEGER FUNCTION RANGE (I,J,K,L)

File: GENERAL.FOR

Purpose and Method:

This function computes the distance (in hexes) between two points and converts to an integer.

Parameters:

i,j - integers; first location k,l - integers; second location

Other Major Variables:

rng - integer; distance between two locations

vert - real; vertical distance

horz - real; horizontal distanc

Subroutines Called:

System functions FLOAT, SQRT, and IFIX

Entries:

General Utility

REAL FUNCTION NCACON (SIDE,ROW,COL)

File: GENERAL.FOR

Purpose and Method:

This function computes the probability the JTFHQ can coordinate with the NCA.

Identify Red switches. For each other piece of Red equipment collocated with the JTFHQ, add it to the appropriate list and find probability it will connect to NCA, based on C3E and NCAPAT. For ground terminals, check to see if a satellite beam is in range of the terminal.

Repeat for Green equipment. Compute overall probability of a link to NCA using the formula:

NCACON = 1 - [(1 - HFPROB)*(1 - VLFPRB)*(1 - GTPROB)]

Parameters:

side - character*1; side of JTFHQ

row,col - integers; location of JTFHQ

Other Major Variables:

gtl - integer; list of gtound terminal equipment numbers

vfl - integer; list of vlf equipment numbers

hfl - integer; list of hf equipment numbers

hqsw - integer; number of switch

rng - integer; range from ground terminal to beam center of satellite

hqswp - real; probability of switching properly

vlfp - real; effectiveness of one vlf link

gtp - real; effectiveness of a satellite link

hfp - real; effectiveness of an hf link

pvlft - real; overall effectiveness of vlf links

pgtt - real; overall effectiveness of satellite links

phft - real; overall effectiveness of hf links

q - real; 1-chance of some link to NCA working

satrng - logical; true is a satellite is in range

x,y - logicals; true if systems are compatible

Common Variables Referenced but not Changed:

redeq/grneq	raunit/gaunit	etype
ritem/gitem	rtc3e/gtc3e	ncapat

reqrow/geqrow   rtc3es/gtc3es   beams
reqcol/geqcol   rtcrng/gtcrng

Subprograms Called:

Integer function RANGE
Logical function COMPAT

Entries:

General Utility

REAL FUNCTION C3EXT (SIDE,K,RNG)

File: GENERAL.FOR

Purpose and Method:

This function computes the probability a unit will be in communication with its JTFHQ.

For each item of Red equipment, check to identify switches at ends of link. (The unit normally would not have a switch, but the game allows the inclusion of one.) Look for Red HF, LOS, GTPROB, or TAC equipment and find probability of each forming a link. (See Subroutines HFPROB, LOSPRB, GTPROB, and TACPRB.) Do same for Green equipment. Calculate total probability of communicating with JTFHQ using the formula:

C3EXT = 1 - [(1-HFPROB)*(1-LOSPRB)*(1-GTPROB)*(1-TACPRB)]

Parameters:

side - character*1; side of unit

k - integer; unit number

rng - integer; range from unit to JTFHQ

Other Major Variables:

hfl - integer; list of hf equipment

losl - integer; list of los equipment

gtl - integer; list of ground terminals

tacl - integer; list of tactical equipment

usw - integer; index number of switch at unit, if any

hqsw - integer; index number of switch at hq

uswp - real; effectiveness of unit switch

hqswp - real; effectiveness of hq switch

hfp - real; effectiveness of an hf link

losp - real; effectiveness of an los link

gtp - real; effectiveness of a satellite link

tacp - real; effectiveness of a tactical link

phft - real; overall effectiveness of hf links

plost - real; overall effectiveness of los links

pgtt - real; overall effectiveness of satellite links

ptact - real; overall effectiveness of tactical links

q - real; 1-chance of communicating

Common Variables Referenced but not Changed:

redunt/grnunt	rtc3e/gtc3e
redeq/grneq	rtc3es/gtc3es
raunit/gaunit	ritem/gitem
etype	

Subprograms Called:

Real function HFPROB
Real function LOSPRB
Real function GTPROB
Real function TACPRB

Entries:

General Utility

REAL FUNCTION HFPROB (SIDE,I,K,HQSW,USW,RNG)

File: GENERAL.FOR

Purpose and Method:

This function computes the probability of a given HF equipment item linking up to the JTFHQ.

For HF equipment belonging to unit K, check for compatible HF equipment at JTFHQ, check compatibility with switches, and check range (ground and sky waves). If all requirements are satisfied for a link, the product of the C3E of the two end equipments is the probability of the link. If more than one HF link is possible, use the highest probability.

Parameters:

side - character*1; side of unit

i - integer; index of equipment item

k - integer; index of unit

hqsw - integer; index of switch at hq

usw - integer; index of switch at unit

rng - integer; distance from unit to hq

Other Major Variables:

prob - real; best effectiveness of all hf links

probt - real; effectiveness of a given link

x,y,z - logical; true if systems are compatible

Common Variables Referenced but not Changed:

redeq/grneq   rtcrng/gtcrng   rrow/grow
ritem/gitem   rtc3e/gtc3e   rcol/gcol
reqrow/geqrow   rtc3es/gtc3es   etype
reqcol/geqcol   crngs

Subprograms Called:

Logical function COMPAT
System function MIN

Entries:

Real function C3EXT

<u>LOGICAL FUNCTION COMPAT</u> (I,K,RNG)

File: GENERAL.FOR

Purpose and Method:

This function determines whether two pieces of equipment are compatible at a given range, based on a compatibility table (Attachment A-2f of the Users' Manual).

Parameters:

i,k - integer; index numbers of two systems

rng - integer; distance between systems

Other Major Variables:

patible - logical; true if systems are compatible

x - character*1; value from compatibility table

Entries:

General Utility

<u>REAL FUNCTION LOSPRB</u> (SIDE,I,K,HQSW,USW,RNG)

File: GENERAL.FOR

Purpose and Method:

This function computes the probability of a given line-of-sight equipment item linking up to the JTFHQ directly or through a single relay.

For LOS equipment collocated with unit K, look for compatible LOS equipment at JTFHQ; check compatibility with switches. If within range, link directly; otherwise, look for a ground relay. Check for an airborne relay through an ABNCP or AWACS. LOSPRB is the product of the C3Es of the end equipments and any relays.

Parameters:

side - character*1; side of unit

i - integer; index of equipment item

j - integer; index of unit

hqsw - integer; index of switch at hq

usw - integer; index of switch at unit

rng - integer; distance from unit to hq

Other Major Variables:

rangeu - integer; range from unit to relay

rangeh - integer; range from relay to hq

probt - real; effectiveness of a given los link

prob - real; best los link effectiveness

x,y,z,w,v - logicals; true if systems are compatible

Common Variables Referenced but not Changed:

redeq/grneq	rtc3e/gtc3e	raba/gaba
reqrow/geqrow	rtcrng/gtcrng	rrow/grow
reqcol/geqcol	rawa/gawa	rcol/gcol
etype		

Subprograms Called:

Integer function RANGE
Logical function COMPAT
System function MIN

Entries:

Real function C3EXT

<u>REAL FUNCTION GTPROB</u> (SIDE,I,HQSW,USW)

File: GENERAL.FOR

Purpose and Method:

This function computes the probability of a given ground terminal linking to the JTFHQ through a satellite.

Look for compatible satellites and check range. Check for ground terminals at JTFHQ and check compatibility and range. Find probability for each possible link by multiplying the C3E of the satellite and the C3E of the two ground terminals. If two or more links are possible, use the one with the highest probability.

Parameters:

side - character*1; side of unit

i - integer; index of equipment item

hqsw - integer; index of switch at hq

usw - integer; index of switch at unit

Other Major Variables:

rng - integer; range from ground terminal to a satellite beam center

rngu - integer; minimum range from ground terminal to beam center of a compatible satellite

rngh - integer; range from satellite beam center to JTFHQ

nprob - real; effectiveness of link through a satellite

prob - real; effectiveness of best satellite link

x,y,z,w - logicals; true if systems are compatible

Common Variables Referenced but not Changed:

redeq/grneq	rtc3e/gtc3e	rbeam/gbeam
reqrow/geqrow	rtcrng/gtcrng	etype
reqcol/geqcol	ritem/gitem	

Subprograms Called:

Integer function RANGE
Logical function COMPAT
System function MIN

Entries:

Real function C3EXT

REAL FUNCTION TACPRB (SIDE,I,RNG)

File: GENERAL.FOR

Purpose and Method:

This function computes the probability of a direct link with the JTFHQ using a given tactical comm equipment item.

Check for compatible TAC equipment at JTFHQ; check compatibility and range of the equipment. The probability for the link is the product of the C3E of the two equipments. If two or more links are possible, use the one with the highest probability.

Parameters:

side - character*1; side owning equipment

i - integer; index of equipment

rng - integer; distence from unit to JTFHQ

Other Major Variables:

probt - real; effectiveness of a tactical link

prob - real; best tactical link effectiveness

x,y,z - logicals; true if systems are compatible

Common Variables Referenced but not Changed:

redeq/grneq	rtcrng/gtcrng	rrow/grow
reqrow/geqrow	rtc3e/gtc3e	rcol/gcol
reqcol/geqcol	ritem/gitem	etype

Subprograms Called:

Logical function COMPAT
System function MIN

Entries:

Real function C3EXT

<u>REAL FUNCTION INTC3</u> (SIDE,I,ROW,COL)

File: GENERAL.FOR

Purpose and Method:

This function computes the internal communications ability of a unit.

Find tactical gear assigned to the unit; adapt effectiveness for local terrain by checking internal data and multiplying the C3E of the equipment by appropriate factors. TACP is the effectiveness of each set of tactical equipment. INTC3 is the total effectiveness of all tactical equipment using the formula:

INTC3 = 1 - [(1-TACP(1))*(1-TACP(2))* ... (1-TACP(n))]

Parameters:

side - character*1; side of unit

i - integer; index number of unit

row,col - integers; location of unit

Other Major Variables:

tacl - integer; list of tactical equipment

taco - real; effectiveness of a tactical set

c3eff - real; effectiveness of a tactical set

q - real; 1- chance of communicating

prob - real; chance of internal connectivity

Common Variables Referenced but not Changed:

redeq/grneq	rrow/grow	rtc3e/gtc3e
reqrow/geqrow	rcol/gcol	etype
reqcol/geqcol	ritem/gitem	hex

Entries:

General Utility

SUBROUTINE CHECK (ROW,COL)

File: GENERAL.FOR

Purpose and Method:

This routine checks the validity of input map coordinates by making sure the row number is less than or equal to 66 and the column number is less than or equal to 60 and either both are odd or both even. If the numbers are not valid hex coordinates, the routine asks for and checks new row and column values.

Parameters:

row,col - integers; location being tested

Other Major Variables:

test - real; odd/even test value

Subprograms Called

System function FLOAT

Entries:

General Utility

SUBROUTINE RPOSIT/GPOSIT ()

File: GENERAL.FOR

Purpose and Method:

This routine displays the unit name, location, goal, and combat points for each unit. For each unit, write values presently in the common variables.

Common Variables Referenced but not Changed:

redunt/grnunt	gamtrn
rrow/grow	rgoal/ggoal
rcol/gcol	rcmbtp/gcmbtp

Entries:

Subroutine RTURN/GTURN
Subroutine ENDWAR

SUBROUTINE RTERAIN/GTERAIN ()

File: GENERAL.FOR

Purpose and Method:

This subroutine adjusts the temporary range and C3 effectiveness of comm equipment based on terrain.

Set temporary values initially equal to basic values for that equipment type. If the equipment is ground equipment adjust for basic terrain (excluding mountains). Check path from equipment to JTFHQ for mountains (use optimum path to simulate line of sight). If hills/mountains are at least two hexes wide and closer than three hexes, adjust comm effectiveness by a factor of 0.75.

Major Variables:

re,ce - integers; location of equipment

rb,cb - integers; location of blocking mountain

begin - integer; start of path for mountain check

Common Variables Changed:

```
rtc3e/gtc3e          rtcrng/gtcrng
rtc3es/gtc3es
```

Common Variables Referenced but not Changed:

```
readeq/grneq      rpathr/gpathr      crng
reqrow/geqrow     rpathc/gpathc      crngs
reqcol/geqcol     rstart/gstart      c3e
rrow/grow         ritem/gitem        c3es
rcol/gcol         raunit/gaunit      hex
etype
```

Subprograms Called:

Subroutine OPTIM
Integer function RANGE

Entries:
Subroutine RTURN/GTURN
Subroutine RCOMM1/GCOMM1

SUBROUTINE OPTIM (SIDE,K,ROW,COL,NROW,NCOL,FORCE)

File: GENERAL.FOR

Purpose and Method:

This routine uses a variation of the Dijkstra Algorithm [Ref. 7] to find the shortest distance from the current position to the destination. It takes into account the type of unit and the terrain by call Subroutine PNTS. The path will not allow ground units to cross lakes or seas or ships to cross land. Ground units will go through passes or over mountains, whichever requires fewer points.

Check validity of destination for type of unit. Set initial values of arrays, map borders, and origin (starting point). For present node, find additional points necessary for given force to go to each adjacent hex. Find the unexplored node closest to the origin; this is the next node to be explored. Move to next node. Trace path back from destination to origin. Reverse path and set the array element after the destination equal to zero.

Parameters:

side - characte*1; side looking for path

k - integer; index of unit

row,col - integers; present location of unit

nrow,ncol - integers; destination

force - character*5; type of unit

Other Major Variables:

er,ec - integers; E array for algorithm; calling hex

d - real; D array; path length from origin

f - integer; F array; 0 for unexplored nodes, 1 if explored

min - real; minimum distance to next node

bpathr,bpathc - integers; reverse path form destination back to origin

nextr,nextc - integers; next node to be explored

up,dn,us,ds,ls,rs - integers; coordinates of adjacent nodes

rr,cc - integers; temporary holding for r and c

r,c - integers; present node

nr,nc - integers; one hex from goal

dist - real; distance to present node

distur,distul,distu,distd,distdr,distdl - real; distances to adjacent hexes

Common Variables Changed:

rpathr/gpathr	rstart/gstart
rpathc/gpathc	rend/gend
rgoal/ggoal	rlenth/glenth

Subprograms Called:

Real function PNTS

Entries:

Subroutine REDGOAL/GRNGOAL
Subroutine RTERAIN/GTERAIN
Subroutine RRECON/GRECON

SUBROUTINE RTURN/GTURN (STOPAT)

File: RED.FOR/GREEN.FOR

Purpose and Method:

This subroutine offers a menu of possible actions, inputs the player's choice, calls the appropriate subroutine, and then loops back for another choice.

Initialize temporary values for equipment. Present player action menu.

Parameters:

stopat - real; scheduled time for end of turn

Major Variables:

choice - character*1; menu selection

airlft - logical; true if an airdrop has already been requested for this turn

Common Variables Changed:

rrecce/grecce

Subprograms Called:

Subroutine REDGOAL/GRNGOAL
Subroutine RCOMM/GCOMM
Subroutine RRECON/GRECON
Subroutine RCACAS/GCACAS
Subroutine RPOSIT/GPOSIT
Subroutine RSEALIFT/GSEALIFT
Subroutine RAIRLIFT/GAIRLIFT
Subroutine RATKSAT/GATKSAT
Subroutine RTERAIN/GTERAIN

Entries:

Subroutine REDOPS/GRNOPS

SUBROUTINE REDGOAL/GRNGOAL ()

File: RED.FOR/GREEN.FOR

Purpose and Method:

This routine allows the player to change the movement goal of a combat unit, displays a projected path, and allows the player to input an interim point to take another path.

Input unit name and check identity of the unit. Check communications link to see if change of orders can be sent to the unit. Display present goal of unit and ask player if he wants to change it. Ask for new goal, '0 0' to be input to stop a unit in its present position. Output new goal and proposed path. If the unit is a sealifted Marine force, the goal remains that of the Amphibious Task Force carrying the Marines.

Major Variables:

unitna - character*8; name of unit input by player

effc3 - real; effectiveness of comm link to JTFHQ

rng - integer; distance to hq

rn - real; random number

Common Variables Changed:

rgoal/ggoal

Common Variables Referenced but not Changed:

redunt/grnunt	rpathr/gpathr	rlenth/glenth
rrow/grow	rpathc/gpathc	rseal/gseal
rcol/gcol	rstart/gstart	seed
rforce/gforce	rend/gend	

Subprograms Called:

Subroutine OPTIM
Real function C3EXT
Real function NCACON
System function RAN

Entries:

Subroutine RTURN/GTURN

<u>SUBROUTINE RCACAS/GCACAS</u> ()

File: RED.FOR/GREEN.FOR

Purpose and Method:

For each air wing, the player selects the mission configuration for this turn. Mission choices are interdiction, counter air, and close air support.

Check unit list for flying wing. For each wing offer mission choice. If interdiction mission is selected, input 5 targets. If close air support or counter air missions are selected, set temporary values for the mission.

Common Variables Changed:

rtintd/gtintd	rtcasv/gtcasv
rintd/gintd	rtcav/gtcav

Common Variables Referenced but not Changed:

rforce/gforce	rcasv/gcasv
redunt/grnunt	rcav/gcav

Subprograms Called:

Subroutine CHECK

Entries:

Subroutine RTURN/GTURN

SUBROUTINE RRECON/GRECON ()

File: RED.FOR/GREEN.FOR

Purpose and Method:

This routine allows the player to request satellite survey of one or more columns of the map to find the locations of enemy units. The player can also request reconnaisance flights (at the expense of other air support).

Offer choice of satellite or air recon. If satellite recon is selected, review list of equipment for 'spy' satellites, display beam width(crng), and input westernmost column to be surveyed. If air mission is selected, input start and end points of mission and unit name of wing to fly the mission.

Major Variables:

unitna - character*8; unit name input by player; flying wing to be assigned recce mission

a,b - integers; starting point for recce flight

c,d - integers; end point of recce flight

Common Variables Changed:

ricol/gicol	rpathr/gpathr
rrecce/grecce	rpathc/gpathc
rstart/gstart	

Common Variables Referenced but not Changed:

redunt/grnunt	ritem/gitem
rforce/gforce	etype
redeq/grneq	crng

Subprograms Called:

Subroutine OPTIM
Subroutine CHECK

Entries:

Subroutine RTURN/GTURN

SUBROUTINE RAIRLIFT/GAIRLIFT (AIRLFT)

File: RED.FOR/GREEN.FOR

Purpose and Method:

Each side can airlift one airborne force each turn. The player identifies the unit. If it is located on an airfield, it is immediately moved to the new location. The airlift does not subtract from other air missions.

Indicate if airlift has already been used for this turn. Otherwise, input name of unit to be airlifted. Verify name if that of an existing, airborne unit. Check location to make sure unit is on an airfield. If all conditions are met, set variables for the drop.

Parameters:

airlft - logical; true if airlift has already been requested for this turn

Other Major Variables:

fly - integer; index used to identify whether identity of unit to be airlifted has been matched

unitna - character*8; name of unit to be airlifted

row,col - integers; drop zone location

Common Variables Changed:
rdrop/gdrop
rlift/glift

Common Variables Referenced but not Changed:

redunt/grnunt	rrow/grow
rforce/gforce	rcol/gcol

Subprograms Called:

Subroutine CHECK

Entries:

Subroutine RTURN/GTURN

SUBROUTINE RSEALIFT/GSEALIFT ()

File: RED.FOR/GREEN.FOR

Purpose and Method:

This subroutine embarks Marine forces providing their position and that of the Amphibious Task Force are appropriate. (They must be in adjacent sea and shore hexes.)

Offer choice of embarking or disembarking. If embarking, review list of sealifted forces to see if ships are available. Input unit to be sealifted and verify it is an existing Marine unit. (Allow reject to main menu.) Check to see if unit and ships are in adjacent hexes, if so set appropriate variables to embark. Output messages if sealift is not available or locations are wrong. If disembark is selected, input and verify name of unit. If unit is amphibious, verify that it is presently embarked on an ATF, and verify location of ships is along shore. If conditions are met, set variables for landing.

Major Variables:

unitna - character*8; name of unit to be sealifted

bottom,top,left,right - integers; coordinates of adjacent hexes

ships - logical; indicates availability of amphibious task force

lift - logical; indicates locations are appropriate

row,col - integers; possible landing zone

Common Variables Changed:

rseal/gseal	rgoal/ggoal
rrow/grow	rland/gland
rcol/gcol	rshore/gshore

Common Variables Referenced but not Changed:

redunt/grnunt	hex
rforce/gforce	

Entries:

Subroutine RTURN/GTURN

<u>SUBROUTINE RATKSAT/GATKSAT</u> ()

File: RED.FOR/GREEN.FOR

Purpose and Method:

This module allows the player to request use of an anti-satellite weapon. Connectivity to NCA is required reguardless of rules of engagement.

Major Variables:

count - integer; number of weapons available

list - integer; list of weapon indexes

scount - integer; number of satellite targets available

slist - integer; list of target indexes

comm - real; connectivity to NCA

rn - real; random number

num - integer; index number of target selected

Common Variables Changed:

rtargt/gtargt
rweapn/gweapn

Common Variables Referenced but not Changed:

redeq/grneq	etype
ritem/gitem	beams
rtc3e/gtc3e	

Subprograms Called:

Real function NCACON
System function RAN

Entries:

Subroutine RTURN/GTURN

REAL <u>FUNCTION RPOINT/GPOINT</u> (I,C3EFF)

File: RED.FOR/GREEN.FOR

Purpose and Method:

This function calculates the mobility points of a unit, considering the type of unit, the mobility of any comm equipment they are carrying along, and the effectiveness of their tactical communications.

Set points initially for type of unit. Make adjustment for mobility of comm gear. (If the mobility of the comm gear is less than that of the combat unit, the unit must slow down to the speed of the equipment.) If forces are sealifted, adjust mobility to be that of ships. Adjust for effectiveness of tactical comm. If INTC3 is less than a random number the movement points of the unit are multiplied by a factor of 0.5.

Parameters:

i - integer; index of unit

c3eff - real; internal comm effectiveness

Other Major Variables:

pnts - integer; value of movement points

rpnts - real; real equivalent of pnts

Common Variables Referenced but not Changed:

redunt/grnunt	rumob/gumob	mob
redeq/grneq	raunit/gaunit	seed
ritem/gitem	rseal/gseal	

Subprograms Called:

System functions RAN and FLOAT

Entries:

Subroutine RMOVE/GMOVE

SUBROUTINE RMOVE/GMOVE ()

File: RED.FOR/GREEN.FOR

Purpose and Method:

This subroutine moves each unit along the projected path toward its goal. Movement is affected by terrain and by the unit's movement points. The movement points of a unit are obtained by calling Subroutine RPOINT or GPOINT. These points are then compared by Subroutine MVMENT with the points required for that type of unit to enter the next hex. If the unit has sufficient points, the movement is made. Movement continues until the goal is reached, all movement points are used, or the unit enters the control zone of an enemy unit (in which case the player can choose to retreat, attack, or go on toward its goal).

Loop through units. If a unit is sealifted, wait to move it. If unit is debarking, set new position and check for enemy in the area. If the unit is being airdropped, set their new position and check for enemy in the area. If the unit is not sealifted or airlifted, check internal comm and calculate movement points. Move the unit until out of movement points, at goal, or in enemy control zone. If not in retreat, call MVMENT to make a one-hex movement. If in an enemy control zone, offer player choice of retreating, continuing on toward goal, going into a defensive position, or requesting approval of an attack. If in retreat, move backwards at half speed until out of movement points. Set new position of all mobile comm gear assigned to the unit. Check to see if movement should stop. If any units are sealifted, set their new position the same as their ships' position.

Major Variables:

mvpnts - real; movement points of unit

temp - real; temporary value of points; holds original points while adjustments are made for slower retreat speed

used - real; number of points used in a one hex retreat

retret - logical; indicates if unit is retreating

cnflct - logical; indicates unit is in the control zone of an enemy unit

wait - logical; there is at least one sealifted unit

wait2 - logical; the given unit is sealifted and must move with the ships

row,col - integers; landing zone for sealifted unit

Common Variables Changed:

```
reqrow/geqrow     rrow/grow        rdrop/gdrop
reqcol/geqcol     rcol/gcol        rlift/glift
rcnlst/gcnlst     rland/gland      owner
rstart/gstart     rshore/gshore    lasown
rgoal/ggoal
```

Common Variables Referenced but not Changed:

```
redunt/grnunt     rseal/gseal
rforce/gforce     raunit/gaunit
```

Subprograms Called:

Subroutine MVMENT
Subroutine ENEMY
Subroutine RLISTEN/GLISTEN
Real function INTC3
Real function RPOINT/GPOINT

Entries:

Subroutine OPNCTL

SUBROUTINE RCOMM/GCOMM ()

File: RED.FOR/GREEN.FOR

Purpose and Method:

This subroutine allows the player to detach comm equipment from a unit and set it up as a separate fixed or mobile comm detachment. The player can also assign airborne command post orbits or change comm satellite orbits and beam locations, and change the mission assignments of electronic warfare systems.

Offer choice of actions. If ABNCP orbit change is desired and one is available for this turn, input new orbit center and change values. If player wants to detach comm equipment, input equipment and owning unit. Input new unit name for the detachment. If a unit by that name owns the equipment designated, detach the equipment, setting necessary variables. The unit type is now 'relay', the mobility is that of the equipment, the unit has no combat points, and no initial goal. If the player wants to change a comm satellite orbit and/or beam position, review the equipment list for comm satellites. Output the satellite name, present position, and beam centers; and input new centers. If the player wants to change EW system missions, list systems and get choice of modes.

Major Variables:

found - logical; true if equipment or unit is matched

arow,acol - integers; orbit locations of ABNCP

goback - logical; true if input equipment of unit is not found in lists

Common Variables Changed:

redunt/grnunt	reqrow/geqrow	raba/gaba
rrow/grow	reqcol/geqcol	rforce/gforce
rcol/gcol	raunit/gaunit	rcmbtp/gcmbtp
rumob/gumob	rbeam/gbeam	rmode/gmode
rgoal/ggoal		

Common Variables Referenced but not Changed:

ravalb/gavalb	rab/gab	mob
redeq/grneq	rabl/gabl	beams
ritem/gitem	etype	seed

Subprograms Called:

Subroutine CHECK
System function RAN

Entries:

Subroutine RTURN/GTURN

SUBROUTINE RCOMM1/GCOMM1 ()

File: RED.FOR/GREEN.FOR

Purpose and Method:

This subroutine is called only on the first turn of the Operations portion of the game. It allows the player to make initial allocation of comm equipment to a combat unit, fixed location, or mobile comm relay detachment.

List all equipment assigned to the player. For each equipment item, individually, determine type of equipment. If it is an ABNCP or AWACS, simply list it for later reference. If equipment is a satellite, identify the nomenclature, number of beams and beamwidth. Allow the player to input the center of each beam. If the equipment is an Intelligence satellite, identify it to the player; missions will be assigned in RECON module. If the equipment is an anti-satellite weapon, identify it to the player. Missions will be assigned in ATKSAT module. For fixed equipment, allow player to input the location. For mobile equipment, allow player choice of assigning to a particular combat unit or setting it up as a separate comm detachment. For equipment to be assigned to a combat unit, input the unit name and set the location of the equipment to match.

For equipment to be used as a separate detachment, input the location and new unit name. Set force type to 'relay', set mobility points, combat points, and goal. If AWACS is available, calculate percentage of availability, based on the number of planes. If ABNCPs are available, calculate the percentage of availability; missions will be assigned in the COMM routine of each turn. Set temporary C3 effectiveness of equipment based on terrain at the initial location.

Common Variables Changed:

redunt/grnunt	reqrow/geqrow	raw/gaw
rforce/gforce	reqcol/geqcol	rawl/gawl
rrow/grow	raunit/gaunit	rab/gab
rcol/gcol	ravalb/gavalb	rabl/gabl
rgoal/ggoal	ravalw/gavalw	rawa/gawa
rumob/gumob	rcmbtp/gcmbtp	raba/gaba
rown/gown	rlas/glas	

Common Variables Referenced but not Changed:

redeq/grneq	etype	crnq
ritem/gitem	beams	mob

Subprograms Called:

Subroutine RTERAIN/GTERAIN
Subroutine CHECK

Entries:

Subroutine REDOPS/GRNOPS

6. PREPARING ALTERNATE GAMES

6.1 DATA BASE SETS

There are five basic data sets needed to play COMEL (Map, System Information, Equipment Lists, Unit Lists, and Combat Results Table). Any one set may be changed without changing the others. By changing the data files you can tailor the battle to match a real world batle or determine the relative value of two different electronic systems.

6.1.1 The Map

There are three sets of map data arrays and a fourth file identifying the key objectives. One array indicates the basic terrain type of each hex (open,desert, etc.); the second indicates roads; the third shows rivers. To enter a new map, you must prepare four data files, as described in Section 6.2. When you name the new files, be sure not to use the same names as the default files (HEX.DAT, RHEX.DAT, VHEX.DAT, and KEY.DAT). When the map information files are replaced the Operations Plan and Commander's Assessment (Attachments A-7 through A-10 of the Users' Manual) should also me replaced.

6.1.2 The System Information

Technical data and cost information on the electronic systems takes two files, one for the primary data and one for a compatibility table. The technical data includes the mobility, range, effectiveness, and other information. The cost data, included in the same file, gives costs and time required for development, purchase, operations, etc. The compatibility table indicates which comm systems are compatible with each other and with systems for the NCA. It also shows which EW equipment is effective against which comm systems. The system and compatibility information must match, so either both default files or both new files must be used. Section 6.3 describes in detail the format of these files. Do not use the default file names (SYSTEM.DAT and TABLE.DAT).

The file SYSINF.DEF includes general information about the systems, which can be displayed on the players' screens. This file should be replaced by a similar file for the new systems.

6.1.3 The Equipment Lists

The equipment lists show each actual, individual end item of equipment available to the Joint Task Forces. Each entry includes a link to the appropriate entry in the system file. Four default files are available, Red and Green files for the Acquisition Phase and Red and Green files for the Operations Phase. The file names for the default lists are

REQUIP.EXT, GEQUIP.EXT (for the Operations Phase), REQUIP.DEF, and GEQUIP.DEF (for the Acquisition Phase or a complete game). New equipment lists can be prepared on the editor, using the directions in Section 6.4. If only the Operations Phase is being played, the controller can also build the lists interactively at the beginning of the first game turn.

6.1.4 The Unit Lists

The unit lists indicate the combat units available to each side, with information on their mobility, initial location, and combat values. The default lists are in REDUNIT.DEF and GRNUNIT.DEF. New lists can be built in edit by following the instructions in Section 6.5, or interactively at the beginning of the Operations Phase.

6.1.5 Combat Results

The combat results table is a matrix using the difference in combat value of two units and a random number to designate the outcome of land combat. The default file is TABLE2.DEF; instructions for preparing a new file are in Section 6.6.

6.2 PREPARING A NEW MAP

The map for COMEL is made up of a 66 row, 60 column hexagonal layout. The numbering system is described in Section 1.4 of the Users' Manual. Each hex represents an area about 5 miles across, so the entire map is therefore

about 178 miles by 300 miles. To prepare a new map from a real world map, make a scaled copy of the map on appropriately sized hex paper, or overlay the map with a clear plastic overlay of the appropriate size hexes. Work in rows, identifying the area of the map in each hex as primarily open(o), mountains(m), woods(w), desert(d), lake(l), or sea(s). List the data in alternating file columns so that it makes a checkerboard pattern, as in Figure B-1.

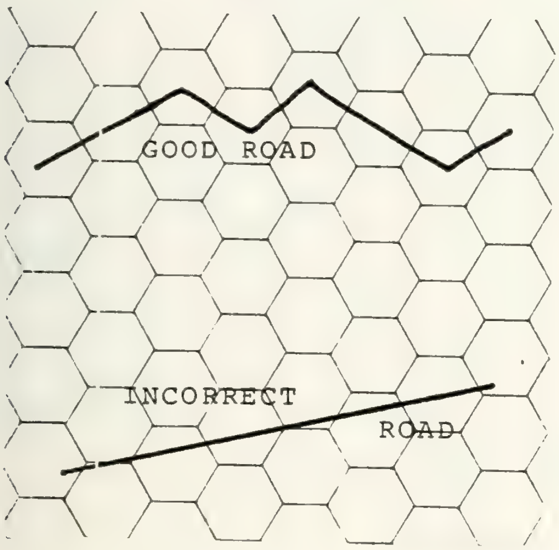
```
o o o o m a o s s s s s s s s s s s s
 o o o o m m w w o o o o o s s s s o o
o o o o m m w w w o o o o s s s s o o
 o o o o w w w w o o o o o o s o o o o
o o o o o w w w o o o o o o c c o o o
 o o o o w w w w o o o o o o c o o o o
o o o o o w w w o o o o o o o o o o o
 o o o o w w w o o o o o o o o o o o o
l o o o l l l l d d d d d d d d d d d
 l o c l l l l l d d d d d d d d d d d
l o c c l l l l d d d d d d d d d d d
 l o c l l l l d d d d d d d d d d d d
l o o o l l l l d d d d d d d d d d d
 l o o o l l l d d d d d d d d d d d d
```

HEX MAP CHECKERBOARD

Figure B-1

Next you must trace any roads you want to include. You will have to decide whether to show all roads or only major highways, depending on the density of the road system. Make a second, similar checkerboard pattern with zeros where there are no roads and '1' for hexes with roads. Make sure

that the resulting pattern makes a route that can be followed from hex to hex with no breaks (see Figure B-2).




```
 0 0 0 0
0 1 1 0
 1 1 1 1
1 0 0 1
 0 0 0 0
0 0 0 0
 0 0 0 0
0 0 0 0
 0 0 0 1
0 0 1 1
 1 1 1 0
1 1 0 0
 1 0 0 0
```

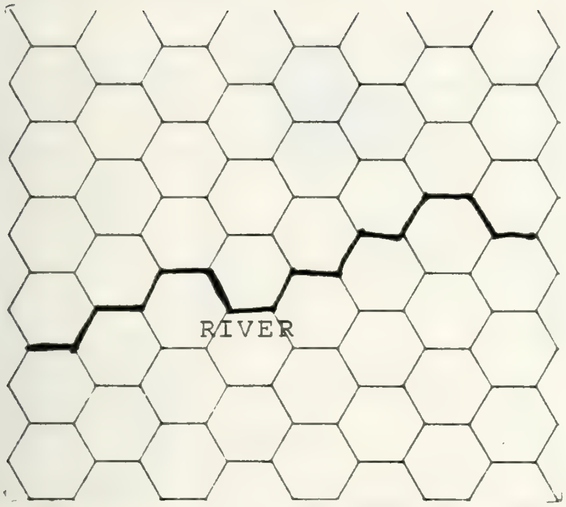
TRACING ROADS THROUGH HEXES

Figure B-2

A unit going from a '1' hex to a '1' hex is traveling along a road and can move faster.

Prepare a third checkerboard to show rivers. Rivers must appear to flow along the borders between hexes, so determine on your hex paper which route is the closest approximation of the actual path of the river. Label hexes on one bank of the river with '1' and those hexes on the opposite bank with '2', as in Figure B-3.

A unit moving between two hexes with total value of 3 must be crossing the river. If two units are fighting from adjacent hexes with a total value of 3, the river is between them and the defender has an advantage.




```
 0 0 0 0
0 0 0 0
 0 0 0 0
0 0 0 2
 0 0 2 2
0 2 2 1
 2 2 1 1
2 1 1 0
 1 1 0 0
1 0 0 0
 0 0 0 0
0 0 0 0
```

TRACING RIVERS THRUOGH HEXES

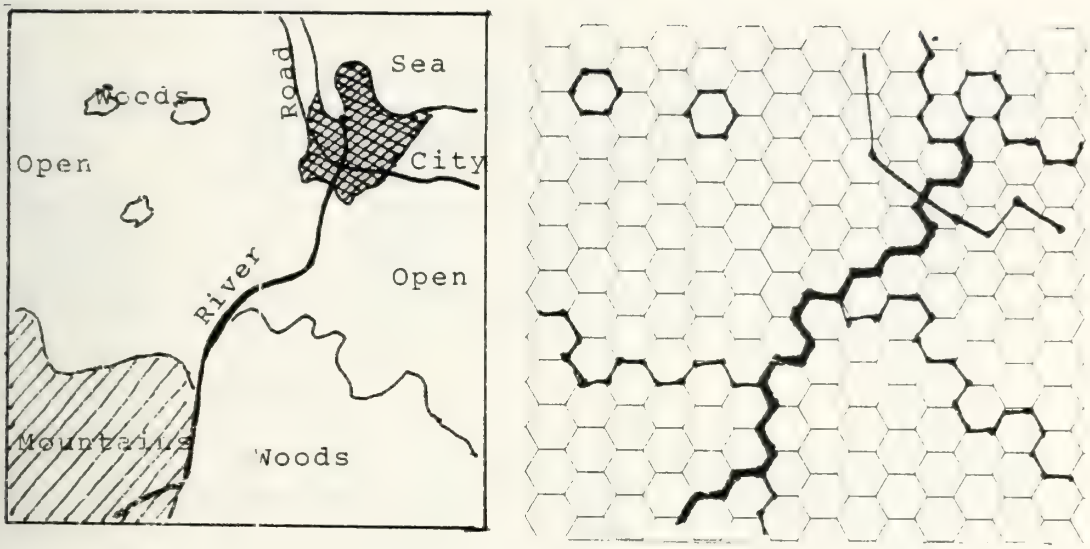
Figure B-3

Finally make a list of hexes with major and mino objectives. The list should show the major objectives (row then column in file columns 1-2 and 20-21), then sentinals (-1 -1), then the minor objectives, then sentinals. The list of objectives for the default game may be used as an example; it is in file KEY.DEF

A small portion of a map and the equivalent hex map are shown in Figure B-4.

6.3 PREPARING A SYSTEM LIST

Each system requires three lines of data in the system listing; the first line identifies the system and the general equipment type, the second has technical data, the third has cost data. The data items, measurement units,



MAP TRANSLATION

Figure B-4

data type, maximum range, a sample entry, and the file columns are as follows:

LINE 1

item	unit	data type	range	sample	columns(1)
system name	-	char*8	-	hftty 2	2-9
system type(2)	-	char*5	-	hf	10-14

Note 1: File columns are critical. Character variables should be left justified and integers right justified in the listed columns.
Note 2: System type must be one of the twelve listed in Section 1.5

LINE 2 - EW SYSTEMS

item	unit	data type	range	sample	columns(1)
mobility	hex	integer	0-999	6	4-6
range	hexes	integer	0-9999	35	9-12
EW factor	-	integer	0-20	7	17-18
ECM value	-	real	-1.0-0.0	-0.75	19-24
ESM value	-	integer	0-5	1	30

LINE 2 - HF SYSTEMS

item	unit	data type	range	sample	columns(1)
mobility	hex	integer	0-999	8	4-6
ground wave range	hexes	integer	0-9999	6	9-12
sky wave range	hexes	integer	0-9999	9999	15-18
security factor	-	integer	0-5	1	24
reliability	%	real	0.0-1.0	0.85	26-30
rel/sky wave	%	real	0.0-1.0	0.78	32-36
flexibility	%	real	0.0-1.0	0.84	38-42
optimization	%	real	0.0-1.0	0.92	44-48
C3E(3)	%	real	0.0-1.0	0.91	50-54
C3E/sky wave	%	real	0.0-1.0	0.78	56-60

Note 3: This number in the default file (See Section 2) is the product of reliability, flexibility, and operability. For communications systems, the square root of the product represents the C3E of one end of a communications link. Any method of calculating the C3Effectiveness may be used, since the C3E and C3E(sky wave) are used in the game but REL, RELS, FLEX, and OPT are not.

LINE 2 - COMMUNICATIONS SATELLITES

item	unit	data type	range	sample	columns(1)
mobility	hex	integer	999	999	4-6
beam width	hexes	integer	0-9999	6	9-12
# of beams	-	integer	1-10	4	17-18
security factor	-	integer	0-5	2	24
reliability	%	real	0.0-1.0	0.85	26-30
flexibility	%	real	0.0-1.0	0.84	32-36
operability	%	real	0.0-1.0	0.92	38-42
C3E(3)	%	real	0.0-1.0	0.91	44-48

LINE 2 - ANTI-SATELLITE WEAPONS

item	unit	data type	range	sample	columns(1)
mobility	hex	integer	999	999	4-6
range	hexes	integer	0-999	6	9-12
reliability	%	real	0.0-1.0	0.85	14-18
flexibility	%	real	0.0-1.0	0.84	20-24
operability	%	real	0.0-1.0	0.92	26-30
C3E(3)	%	real	0.0-1.0	0.91	32-36

LINE 2 - ALL OTHERS

item	unit	data type	range	sample	columns(1)
mobility	hex	integer	999	999	4-6
range	hexes	integer	0-999	6	9-12
security factor	-	integer	0-5	2	17-18
reliability	%	real	0.0-1.0	0.85	20-24
flexibility	%	real	0.0-1.0	0.84	26-30
operability	%	real	0.0-1.0	0.92	32-36
C3E(3)	%	real	0.0-1.0	0.91	38-42

LINE 3

item	unit	data type	range	sample	columns(1)
number available	-	integer	0-99	14	5-6
R&D cost	$M	integer	0-999	2	10-12
R&D time	years	integer	0-5	2	18
Accelerated R&D cost	$M	integer	0-999	4	22-24
Accelerated R&D time	years	integer	0-5	1	30
Manufacturing cost	$M	integer	0-999	7	34-36
Manuf. time	years	integer	0-5	3	42
Normal O&M cost	$M	integer	0-999	1	46-48
Reduced O&M	$M	integer	0-999	1	52-54

An example of a three-line entry for a system is:

```
 artac 1 tac
     7     3     1 0.780 0.750 0.880 0.714
     4     0     0     0     0    12     1     8     4
```

Up to 49 separate systems may be entered. After the last system, enter a '-1' in columns 2 through 3 and 10 through 11 of the next empty line. These will act as sentinals. If you wish to add a system that does not exactly match any of the system types listed, you must improvise to the closest fit. Addition of another type of system to the game would require major revision to the game (See Section 5.4.4).

A matching compatibility table must be prepared. This table is a two dimensional matrix with the row numbers and column numbers corresponding to the index numbers of the systems in the system list. Each matrix entry (i,j) tells

whether system i is compatible with system j or, in the case of an EW system, whether i is effective against j. The matrix entry is an 'n' if the systems are not compatible, 't' if they are compatible, 'w' if they are compatible only if connected by wire, and 'g' if compatible only at very short range (one hex).

A matching general information is also be needed, to be shown on the players' screens. Each system type has two to ten lines of general information on the use of the system. The default file can be used unless new system types have been added to the game.

The system information for the default game may be used as examples. The default system list is in file SYSTEM.DEF, the matching compatibility table is in TABLE.DEF, and the matching general information is in SYSINF.DEF.

6.4 PREPARING NEW EQUIPMENT LISTS

Equipment lists for the Operations Phase require only three data items (End Item Name, System Number, and Percent of Readiness).

item	unit	data type	range	sample	columns(1)
end item name	-	char*8	-	hftty 2	2-7
system #(4)	-	integer	1-49	32	8-13
% Readiness	%	real	0.0-1.0	0.85	14-19

Note 4: The system number is a link to the index of the matching system from the system list. For example, in the default game Red has 12 hftty equipment items, each of which is linked to system number 8, hftty 2.

After the last unit, enter a '-1' in the first two data columns to act as a sentinal. No more than 99 equipment items can be used for each side. The default files, REQUIP.EXT and GEQUIP.EXT can be used as examples.

6.5 PREPARING NEW UNIT LISTS

Each unit list has nine data items as follows:

LINE 1

item	unit	data type	range	sample	columns(1)
unit name	-	char*8	-	8th abn	1-8
unit type(5)	-	char*5	-	amph	14-18
row	hex	integer	1-66	42	26-27
col(6)	hex	integer	1-60	36	36-37

LINE 2

item	unit	data type	range	sample	columns(1)
mobility	hexes	integer	0-20	8	6-7
counter-air value(7)	-	integer	0-10	4	19-20
close-air-support(7)	-	integer	0-10	6	32-33
ew-value(7)	-	integer	0-10	4	44-45
air-defense value	-	integer	0-10	6	56-57

Note 5: The type must be one of the eight listed in Section 1.5; the first unit listed must be the JTFHQ.
Note 6: Location row and col must both be odd or both even.
Note 7: Air units only (tfw or cbg), 0 for all others.

A '-1' should be entered in columns 2 and 3 of the line following the last unit, to act as a sentinel. Up to 19 units can by entered for each side. The default lists are in REDUNIT.DEF and GRNUNIT.DEF.

6.6 PREPARING A COMBAT VALUE TABLE

The combat value table is a matrix with the rows being random integers from 0 through 9 (corresponding to the random numbers) and the columns being the relative difference (from -4 through 5) in combat values of two units. (The defender's combat points are subtracted from the attacker's points; if the difference is greater than 5 or less than -4 it is changed to one of those limits.) Each entry in the matrix has two groups of three integers; one group for the attacker and one for the defender. The three integers for each unit tell: (a) how many combat points the unit loses, (b) how many hexes the unit must retreat (back along the approach path), and (c) how many equipment end items are destroyed. For example, if the combat units have a difference in combat units of 2.3 (rounded to 2) and the random number is 6, the table might indicate an outcome of '1 0 0 3 2 1', meaning the attacker loses 1 combat point; the defender looses 3 points, retreats 2 hexes, and loses 1 piece of C3 equipment (the piece with the lowest security factor).

The format of the file, for random number 0, looks like this:

```
1 0 0 2 0 0  1 0 0 2 0 0  2... 0 2 0 0  2 0 0 1 0 0
 2 0 0 0 0 0  1 1 1 0 0 0  2... 2 0 0 0  9 9 9 0 0 0
```

Nine similar sets of numbers are added for the other random numbers. The default file is in TABLE2.DEF.

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